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To Jas W. Keyess 905

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By O. Sackersdorff, Esq.

136 Canal street, New York.

A PHOTOGRAPH OF  
SIR HUMPHREY DAVY,  
THE FIRST EXPERIMENTER IN PHOTOGRAPHY.

# PHOTOGRAPHY.

A

NEW TREATISE,

THEORETICAL AND PRACTICAL,

OF

THE PROCESSES AND MANIPULATIONS

ON

PAPER;

DRIED AND WET:

|

GLASS,

COLLODION AND ALBUMEN.

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BY A. S. HEATH, M. D., AND A. H. HEATH,

CHEMISTS,

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NEW YORK:

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## PREFACE.

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AMONG the many modern inventions and discoveries, Photography claims attention as a valuable and pleasant aid to *art*, and an important auxiliary to science and industry.

Photography has made such rapid progress in the improvement of apparatus, that but little is left even to embellish its paraphernalia.

The word Photography (from the Greek φωτος, light, and γραφω, I write) is used to designate the art or process of fixing images of objects in the *camera obscura*, on any sensitive surface, as of metal, glass, paper, &c., previously coated with chemicals, which are blackened or colored by the action of light.

After the discoveries of Daguerre and Niepce, Mr. Talbot made some successful experiments in this art in England, where soon after he published his process called Calotype, Talbotype, &c.

A great number of experiments have been made to obtain "sensitive matters;" as yet but

one substance has succeeded, viz., the salts of silver.

The iodide of silver is always the principal agent. The mixture of the iodide with the fluoride, cyanide, chloride, bromide, ammonide, phosphate, carbonate, acetate, &c., of silver, is very good to accelerate the formation of images, but used alone they do not produce very good results. We do not at present think it possible to perfect the process without the salts of silver.

One of the happiest combinations is the union of iodide, fluoride, and cyanide of potassium, for we have made experiments with iodide alone; iodide and cyanide; iodide and fluoride; iodide, cyanide, and fluoride. The last formula is the best, giving the most satisfactory results. By using this triple salt at the moment it is formed, proofs may be obtained in two seconds in summer, and in thirty seconds in winter.

It is very important to procure good paper, which would be much more easily obtained if some experienced paper-manufacturer would make photographic paper exclusively. This plan we shall endeavor to secure.

The process on glass, it is true, gives proofs much better than the process on paper, but is pro-

ductive of some inconvenience. Glass is difficult to prepare, not convenient to handle, and it does not receive the image as quick as paper. A proof on glass is fine, but hard and rigid; but with collodion you have a good and a very sensitive plate.

Besides the utility of Photography in obtaining portraits and views, in Europe the arts and sciences are aided by it. Nothing is more easy than to take pictures of insects, animals, plants, inanimate objects, &c., for naturalists, physiologists, pathologists, and botanists. And especially is it useful in the mechanical arts. Nothing is more difficult and tedious than an accurate drawing of complex and complicated machinery. By Photography every desired view may be taken, and with correct proportions and details, of the most intricate mechanism.

In Europe the art has arrived to a high degree of perfection. In this country it is now being practised with success. In France and in England a great many books have been published upon the various branches of photography, photology, and photogenic chemistry. But few or no complete practical works, especially adapted to teach and guide the amateur successfully through the mazy

labyrinths of the art of picture-taking, have been published in this country.

We publish this work with the hope that in it will be found all necessary information to the easy and successful practice of Photography. In it will be found all the new processes, having consulted every valuable source of information from Paris, London, and in this country. We give also the preparation of chemical products, and the best tests of their purity. The phenomena of light have been treated of, on which subject, unhappily, too many photographers are deficient.

In the preparation of this book much care and attention have been given; and if it is the means of improving and advancing this beautiful art, we shall be abundantly rewarded.

We take great pleasure in acknowledging the valuable services of Monsieur H. Dussauce, of Paris, and of those of the venerable Dr. Moore, of this city, who, though an aged gentleman, is an ardent and most successful photographer, at whose suggestion the Astor Library has been enriched with most of the foreign books on this subject.

A. S. HEATH, M. D.

A. H. HEATH.

NEW YORK, June, 1855.

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## INTRODUCTION

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LIGHT is one of the most energetic causes of chemical action, and a great many combinations and decompositions can take place only under the influence of light.

Photography presents very interesting phenomena; its results are very great, but it promises still greater and more important results for the future. The discoveries made in this science have called the attention of chemists to the action of light, and have induced them to make inquiries for the purpose of discovering the nature and essentials of light.

The action that light exercises upon the salts of silver—viz., that from being originally white, the light transforms them to black—was known in the sixteenth century, but it was only in the eighteenth century that its mysteries were examined into. It was at the same epoch that the influence of light on salts of silver was observed,

and Petit published some observations on it in 1722: Chaptal published his sixty-six years later.

In 1777, Sheele published the results of his observations on the nigrescence of chloride of silver, and more particularly those alterations that the chloride of silver suffers under the influence of prismatic rays. He discovered that the chloride of silver, well divided and spread on paper, would turn black much sooner under the influence of a violet ray than under any of the other colors. In 1790, Sennebier found that the chloride of silver, under the influence of the violet ray, became black in fifteen minutes of exposure, and under the red ray it required twenty minutes. In 1801, Wollaston was engaged in the same researches, and these results led Wedgwood into further experiments, and to him is due the honor of having been the first photographer.

In the Journal of the Royal Institution of 1803 we find a note of Wedgwood's, with observations by Davy: this paper is entitled, "Method of Copying Paintings upon Glass, and of making Pictures by the Agency of Light upon Nitrate of Silver."

Here is what Wedgwood says (white paper covered with nitrate of silver serving as an impression-

able surface): "The alteration of the colors is in proportion to the degree of the intensity of the light. In sunshine, two or three minutes will suffice to produce the effect; in the shade, to have the same effect it must remain some hours. The light acts with different degrees of intensity through differently colored glasses. If the shadow of a figure is thrown upon the prepared surface, the parts covered with the shadow remain white, while the other parts turn black. When the color is fixed on paper, it proves fast to such a degree that water, and even soap and water, fails to remove it. Besides this method, there are others. It will be useful to make copies of all subjects that are partly transparent and opaque: natural objects could be copied in this manner."

To this Davy adds: "It has been observed that the image in the camera obscura is too weak to make an impression upon nitrate of silver without a reasonable time." He followed the experiments of Wedgwood, and found that the objects produced by a solar microscope may be copied on paper without difficulty. Experiments have proved that the chloride of silver is more sensitive than the nitrate. The experiments made some years after have confirmed this fact. But

though Wedgwood and Davy obtained images, they were ephemeral, as they did not know the process of making them permanent.

It was in 1819 that Herschel discovered the property of hyposulphite of soda, and its deportment with salts of silver. In 1812 iodine was unknown, and without these agents it was impossible to advance researches.

In 1814 Niepce de St. Victor examined the chemical effects of light. His object was to fix pictures obtained in the camera obscura. He discovered this property of the solar rays to alter various resinous matters. He spread a thin layer of asphaltum on glass, and placed it in the camera : he left it for six hours, and found on the glass a latent image, which became visible in treating the surface with a solvent. The development of the image was made by F. Talbot.

In 1827 Niepce made some experiments at Kew : these pictures have some resemblance to daguerreotypes, but they are inferior. Daguerre began his experiments in 1824, and used nitrate and chloride of silver.

In 1826 Daguerre and Niepce pursued their experiments together. In 1829 Niepce communicated his method to Daguerre in a letter, where he

says : " My discovery that I have named *Heliography*, consists in this—that I produced instantaneously the image of the camera obscura in all graduations from white to black." He then gives the description of his process.

In 1829 Daguerre and Niepce used for the first time iodine to blacken the plate which contains the image. Daguerre, however, has observed some peculiarities on the action of light on the plate treated in this manner. In some of his letters he speaks of a decoction of cass-weed, of phosphorus, and sulphur, as acting on silver the same as iodine. He produced the same effect by the oxidation of the metal.

In 1833 Niepce died, and six years after Daguerre announced his invention. In 1840 the Chamber of Deputies voted him an annual pension of 6000 francs, and one of 4000 francs to the son of Niepce. On this occasion Arago stated that this recompense was awarded for the honor of having presented the scientific and artistic world with one of the most surprising discoveries, and was proud to present it. M. Duchatel, Ministre de l'Intérieur, adds : " This discovery cannot be secured by patents ; when it is well known, everybody may profit by it." Notwithstanding, we find

Daguerre taking out a patent in England, on the 15th July, 1839. Mr. Berry obtained a patent for a foreigner residing in France, on the 31st of January, 1839. Talbot published some remarks on the art of Photography, the 21st of February, the same year. He gives the process of preparing the paper. Here we find the same substances used by Davy, and about the same manipulations of this chemist.

The next communications of importance were those of Herschel, in 1839 and 1840. This paper is entitled, "The Chemical Effects of Light on the Solar Spectrum." Herschel recommends the use of the hyposulphite of soda as a fixing agent; and in the communication of 1840 he recommended the use of a hot solution of hyposulphite of soda in the case of iodide of silver, this salt being less soluble in hyposulphite than the chloride. Herschel also recommends to iodize the paper, by the use of iodide of potassium and nitrate of silver.

At a meeting of the British Association, in July, 1841, Mr. Hunt read a paper with the following title: "The Influence of the Ferrocyanide of Potassium upon the Iodide of Silver, and its extreme sensitiveness in the Photographic Preparations." He gives also the way to prepare the iodized paper

as follows: Take a sheet of good smooth paper; wash it on one side with a solution of nitrate of silver of one drachm dissolved in one ounce of water; dry it, and wash it again in a solution of two drachms of iodide of potassium to six ounces of distilled water; then wash it in distilled water, and dry it in the dark. Herschel in his paper speaks also of the use of the gallic acid as an accelerating agent, but the proofs obtained in this manner were negatives. The reproduction of pictures was the next point which attracted attention. Mr. Hunt is one of those who were the most successful experimenters. He published a paper on the use of iodide of potassium as a photographic agent.

After the process of Herschel, appeared that of Talbot.

In 1840 the art of Photography was advanced by Goddard and Claudet's discoveries that chlorine and bromine, in conjunction with iodine, increased the sensitiveness of the plates. Then a large variety of mixtures were recommended.

One of the most important improvements was made by Niepce de St. Victor, nephew of I. Niepce: his process consisted in covering plates with a thin coating of albumen containing iodine. This coat-

ing takes pictures beautifully, but it is a little too sensitive to take portraits.

Le Gray was the first to suggest the use of the wax paper for the reception of negative images ; this process gives very good results, and is excelled only by the collodion process.

The use of collodion is recent, and it is Le Gray who applied it first. Messrs. Archer, Fry, and Diamond, from London, had, about the same time, also made experiments with collodion, and now this process leaves little to be desired.

The entire domain of the photographic art may properly be divided into the following sections :

- I. Process on metallic plates.
- II. Process on paper.
- III. Process on glass.
- IV. Process for positive paper
- V. Preparation of chemical products.
- VI. Notions on the phenomena of light, and apparatus used in Photography.

PART I.

THE DAGUERREIAN PROCESS.



## THE DAGUERREIAN PROCESS.

---

1. WE have very little to say on this process, which now is very well known; but to have a complete work, it is necessary to speak of it in as brief a manner as its importance will permit.

### I.—CHOICE OF PLATES.

2. The choice of plates is very essential; their good qualities have a great influence in the operations. The best way is to buy them of a special manufacturer. In selecting a good plate, choose such as have a clean metallic aspect, and you ought not to be able to see a trace of copper; if in the plate you have some lines it is nothing for the execution of the picture, but if you make a portrait it is much better to place the lines perpendicular.

## II.—POLISHING PLATES.

3. If the plate is not well polished it is impossible to have a good picture: rotten-stone and rouge are the best substances to use for this purpose. In France they polish with the hand; here they use the apparatus so well known by all Daguerreotypists.

4. The plate is fixed on a small piece of wood; then pour on two or three drops of spirits of turpentine; dust over the plate a little rotten-stone, and with cotton polish carefully the entire surface. After one minute the plate is covered with a black dirt; remove it with cotton, and afterwards pour on the plate some new dried rotten-stone, and clean well; then pour on the plate three or four drops of a mixture of turpentine and rectified alcohol, and mixed with a little rotten-stone; leave it to dry; then take off the rotten-stone.

5. Here they use the rouge with an apparatus to which the foot gives a movement of rotation; the part with which they polish, is of a woollen texture covered with rouge; they give the movement of rotation, and pass the plate on the wheel. Be

sure that the plate is well cleaned ; breathe on the surface of it, when the white color ought to disappear immediately.

### III.—IODIZING THE PLATE.

6. In the bottom of the iodizing box you have some cotton covered with iodine ; on it is a plate of pasteboard, which you take care to clean frequently.

The plate being ready, you place it in the iodizing box, and after some time look at the color ; if it has more color on one side, turn the plate. To see if the color is right, reflect the plate on white paper ; the paper seems in the plate yellow, very dark, beginning to appear slightly pink.

### IV.—EXPOSURE TO THE CAMERA.

7. For this, see what we say in the part which treats on this subject.

### V.—EXPOSURE TO MERCURY.

8. The mercury should be kept in a dark room ; when the proof is in the box, warm the mercury

with an alcohol lamp until the thermometer indicates from 84 to 90 degrees; then remove the lamp; after some minutes look through the glass of the box; after four or five minutes warm it again, and remove the plate. It is good sometimes to filter the mercury, to avoid the formation of the oxide.

#### VI.—WASHING WITH HYPOSULPHITE OF SODA.

9. Take a two-pint bottle; place in it a funnel with a filter; place in the filter about three ounces 60 grains of hyposulphite of soda; pour on water until the bottle is filled. After the plate comes from the mercury box, wash it with filtered water, then pour on the filtered solution of hyposulphite; when all the iodide of silver is dissolved, wash the plate well and fix it.

#### VII.—FIXING BY CHLORIDE OF GOLD.

10. Fixing with chloride of gold is one of the best applications. This discovery is due to M. Fizeau. After you have passed the plate in the solution of hyposulphite of soda, and washed it, place it on the apparatus to fix, and pour on a

solution of chloride of gold, of which we indicate the composition below; warm with an alcohol lamp. After two or three minutes the proof is right; wash it well, and dry it with the alcohol lamp.

11. Here is the composition of the liquor of M. Fizeau:

Dissolve 15 grains chloride of gold in a pound of pure water, and 45 grains of hyposulphite of soda in another pound of water; pour the solution of gold in the hyposulphite: use this liquor as we have indicated.

But MM. Fordos and Galis have discovered a salt of gold, the hyposulphite of gold and soda, which is much better than the former; for you dissolve 15 grains in two pounds of water, and you operate with it as by the process of M. Fizeau.

12. We ought to speak of the accelerating liquors, for some of them are very excellent. In all of these liquors you have iodine and bromine, or iodine and chlorine. We shall give successively some notices on the preparations of these liquids.

### I.—CHLORIDE OF IODINE

13. You obtain it by the passage of chlorine gas

in iodine. Warm iodine a little with an alcohol lamp; iodine becomes liquid very quick. When the liquid is red, the operation is finished. It can be used by two processes: 1. Pour two or three drops of this liquid in a box, and expose the plate, being covered with iodine (yellow color), in this solution; when it is pink, expose it in the camera. 2. Dissolve some drops of this liquid in water, and put the plate in the solution.

## II.—BROMIDE OF IODINE.

### *Gaudin's Preparation.*

14. Take a solution of iodine in alcohol, pour in bromine drop by drop until the mixture becomes very red; add water until it becomes yellow.

### *Claudet's Preparation.*

15. In a bottle containing about one pound of filtered water, pour drop by drop a solution of iodine in alcohol, until the liquid has the color of a solution of tobacco; add then distilled water, saturated with bromine, until the liquid becomes clear, and has a dark-yellow color; then add drop by drop the solution of bromine, until the color becomes light-yellow.

*De Valicourt's Preparation.*

16. In a bottle containing about four ounces of water, pour 30 or 40 drops of bromine, and afterwards add grain by grain of iodine until bromine will not dissolve it. It is very concentrated; to use it, make the following preparation: pour 15 grains in a bottle, and add six or eight ounces of water.

Here is the time of the exposure of the plate to the bromide of iodine:

|                                  |   |                   |
|----------------------------------|---|-------------------|
| For a plate iodized dark-yellow, | - | 25 to 30 seconds. |
| “ “ pink                         | - | 40 “ 50 “         |
| “ “ pink-violet                  | - | 60 “ 70 “         |

## III.—CHLORO-BROMIDE OF IODINE.

17. Take a saturated solution of bromine in water, pour on drop by drop chloride of iodine until the vapors of the bromine disappear; add water until the solution becomes yellow.

Here is the preparation of Baron Gros: he pours in a bottle half a pound of distilled water, dissolves in it 300 grains of chloride of iodine, agitates well, and filters. In this liquid, he adds 300 other grains of iodine, and agitates well; after two hours he fil-

ters. To this mixture he adds 12 drops of bromine—the liquid is then ready.

---

## LIQUIDS

*Which are substituted for the Iodizing Box.*

18. There are only three liquids—Thierry's liquid, the iodide of bromine, and the German liquid.

### I.—THIERRY'S LIQUID.

19. The composition of this liquid is unknown, but it gives very good results. This liquid is used without water. In using it, pour it in a dish; you must use it all day. After finishing, be careful to put the remains in the bottle again. It can be used several months.

### II.—IODIDE OF BROMINE.

20. It is the same as the bromide of iodine, only we have an excess of iodine. You prepare it in the following manner: In some bromide of iodine, with an excess of bromine, pour from the solution of iodine and alcohol until it precipitates a powder; to use it, add water until you have the color of cider.

## III.—GERMAN LIQUID.

21. This liquid is the chloride of iodine of M. Claudet, with water.

22. In the last part of this book, we shall speak of the phenomena of light, and we shall explain the chemical reactions which pass during all operations.



PART II.

PROCESS ON PAPER.



## PROCESS ON PAPER.

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23. THE processes on paper are two, the *dry* and the *wet*. The first is generally practised to take views; the second is preferable for pictures. The dry method is very much cultivated now, for its simplicity and its ready manipulation give to it an advantage over all other processes. There are two processes on dry paper: 1st, on waxed paper; 2d, on unwaxed: these two processes have the same manipulations; only on unwaxed paper, when all is finished, you wax it.

### I.—PROCESS ON WAXED PAPER.

#### *Selection of Paper.*

24. The difficulties are very great to procure paper suitable for this purpose; it must be of a good thickness, uniform texture, well sized and glazed. The manufactories of France and England give a good paper, but we prefer the French;

but still for positive proofs the English is preferable. Before using the paper it must be selected sheet by sheet to see if it is good; if not, it must not be employed. We give the names of some of the best paper manufacturers in England: Watman, Turner, Nash, &c. In France, Lacroix, Canson, &c.

## II.—PREPARATION OF THE WAXED PAPER.

25. Take a copper basin covered with silver, or, if you prefer it, a Daguerreotype plate; this basin should be larger than the paper; place it in a bath of boiling water, and put in some white wax; when the wax is fused, lay upon it a sheet of negative paper, and take particular care not to have any air-bubbles; and when the paper is penetrated by the wax, take the sheet out and put in another one, and repeat the same operation on all sheets; then put the waxed paper between two sheets of red blotting-paper, and pass over it a hot smoothing-iron until all the wax is absorbed; avoid leaving any wax on it: then preserve for use; it is useful to prepare a large quantity, for it is a very disagreeable work.

This paper is very useful for the photographer:

it is transparent, and permits you to see all air-bubbles ; it is very tenacious, and resists all operations ; and when the paper is prepared with the nitrate of silver, you can keep it many weeks. It is much better to buy this paper already prepared.

### III.—SENSIBILIZATION.

26. In this bath the photographer puts sugar of milk and starch ; the object is to introduce into the paper an organic matter, which, with the nitrate of silver, renders it blacker. Put in a porcelain dish—

|                 |   |   |   |                |
|-----------------|---|---|---|----------------|
| Distilled water | - | - | - | 6 pints.       |
| Rice            | - | - | - | 9 oz. 160 grs. |
| Isinglass       | - | - | - | — 300 “        |

Boil until the solution is reduced to three pints ; filter through a clean cloth. This liquid gives body to the paper, and yields very excellent tones of black in the proof. In two pints of this liquid dissolve—

|                     |   |   |   |                   |
|---------------------|---|---|---|-------------------|
| Sugar of milk       | - | - | - | 698 grains.       |
| Iodide of potassium | - | - | - | 225 “             |
| Cyanide             | - | - | - | $12\frac{1}{2}$ “ |
| Fluoride            | - | - | - | $7\frac{1}{2}$ “  |

When all is dissolved, filter it quickly, and keep

for use. This bath is unalterable. Before employing it, filter it through filtering paper.

To operate with this bath and the paper, put the liquid in a porcelain dish, and immerse in it the sheets of paper one by one; remove the air-bubbles, and leave it from half an hour to one hour. After this take all the paper in a mass, and turn it; then take the sheets, and, holding them by the corners, drain them for a time, and then let them remain.

The paper in draining takes a violet tint, which is very useful, as we shall see in the bath of silver. The bath can be used a long time, but you must filter it after each operation.

#### IV.—EXCITING.

27. Prepare the following bath :

|                     |   |   |   |                |
|---------------------|---|---|---|----------------|
| Distilled water     | - | - | - | 9 oz. 330 grs. |
| Nitrate of silver   | - | - | - | — 310 “        |
| Glacial acetic acid | - | - | - | — 360 “        |
| Animal black        | - | - | - | — 120 “        |

After the solution of nitrate of silver, add acetic acid and animal black; agitate it well, and leave it for some hours. Fill a porcelain dish with this bath, and in another dish put the distilled water.

Take the iodized paper, put it in, and remove the air-bubbles; let it remain in for six minutes, or, if you prefer it, when your paper which was blue before becomes white, wash it well in distilled water, and dry it between blotting-paper; keep the water used to wash, it is employed to develop; keep the paper out of the light: all these operations ought to be performed by candle-light. You must take particular care not to touch the paper with the fingers except by the corners. This paper will be good during three or four weeks, but it is preferable to prepare it one or two days before using it; after you have prepared ten sheets, put the nitrate on the animal black, and then filter.

#### V.—EXPOSURE.

28. For this, see Camera, in article on Apparatus.

#### VI.—DEVELOPING OF THE IMAGE.

29. Take a porcelain dish, and put in the following solution :

|                 |   |   |   |   |            |
|-----------------|---|---|---|---|------------|
| Distilled water | - | - | - | - | 1 pint.    |
| Gallic acid     | - | - | - | - | 30 grains. |

Solution used to wash the paper during exciting, 1 ounce.

Immerse the proof in this solution, and agitate it. If the exposure has been correct, the image will appear in 15 or 20 minutes; sometimes it must remain for some hours. As soon as the image is correct, remove it to another porcelain dish, full of water, and wash it well; then fix it. If the exposure has been too short, the proof will be weak, and not distinct in all parts. If the exposure has been too long, or the light too intense, the proof darkens in some minutes in the bath of development. You can accelerate the development if you warm the bath, but it is dangerous; for the development, if you are not careful, will be too rapid.

## VII.—FIXING.

30. You are obliged to fix the proof to dissolve the iodide of silver, which has not received the action of light; the best way is by the hyposulphite of soda.

|                      |   |   |                       |
|----------------------|---|---|-----------------------|
| Take rain-water      | - | - | 1 lb. 10 oz. 100 grs. |
| Hyposulphite of soda | - | - | 3 " 60 "              |

Pour this solution into a dish, immerse the proof,

and leave it until all the iodide of silver is dissolved, which will take from 30 to 45 minutes. You will see that the operation is finished when the dark spots are very intense, and the light very brilliant. When a proof has been fixed, filter the bath before you put in another; then wash it well in water, renewed several times, until it is perfectly clean, and then dry it well.

If the proof has lost its transparency, place it between two sheets of blotting-paper, and pass over it a smoothing-iron until it renews its transparency.

31. When you operate on unwaxed paper, all operations are the same; only when all is finished you wax it, as we have said in the beginning.

You could fix it also with the following bath:

|                      |   |   |   |   |   |             |
|----------------------|---|---|---|---|---|-------------|
| Water                | - | - | - | - | - | 2 pounds.   |
| Bromide of potassium |   |   |   | - | - | 372 grains. |

#### VIII.—PROCESS ON WET PAPER.

32. This process gives very fine results. The paper is prepared in the same manner as in the dry process, and may be waxed or unwaxed.

(a) You immerse the paper in a solution of iodide of potassium, thus formed:

|                     |   |   |                        |
|---------------------|---|---|------------------------|
| Distilled water     | - | - | 100 parts (in weight). |
| Iodide of potassium | - | 5 | " "                    |

You can leave it to dry, as in the wax process.

(b) Float them upon the following solution :

|                   |   |   |   |                 |
|-------------------|---|---|---|-----------------|
| Distilled water   | - | - | - | 1 lb.           |
| Nitrate of silver | - | - | - | — 1 oz. 15 grs. |
| Acetic acid       | - | - | - | — 1 " 120 "     |

Leave them in from eight to ten minutes, and use immediately.

(c) You have a plate of glass: place upon it a sheet of blotting-paper dipped in clean water; place upon it the sensitive paper, which has been previously laid upon blotting-paper, and then expose it in the camera. The action of light is very rapid, and it must be exposed only about two-thirds of the time of waxed paper.

(d) The developing and fixing are the same as for the dry paper.

#### IX.—PROCESS ON ALBUMENIZED PAPER.

33. This process could be substituted for the waxed process: it gives very good results. You operate as follows: Take some white of eggs, and add to them 10 parts of water, and for 100 parts of

this solution dissolve five parts of iodide of potassium; agitate it well, and leave it 12 hours; pour it off, and put the liquid in a porcelain dish, placing on it the paper; leave it five or six minutes, then dry it well between blotting-paper, and afterwards warm it with a smoothing-iron. The other operations are the same as for waxed paper. By this process you obtain some very fine proofs, equally as good as by the waxed paper.

#### X.—DIFFERENT PROCESSES.

34. At first we ought to speak of Talbot's process, for he was the first who ever practised it.

##### *Talbot's Process.*

#### 35. Take

|                   |   |   |   |   |             |
|-------------------|---|---|---|---|-------------|
| Distilled water   | - | - | - | - | 6 ounces.   |
| Nitrate of silver | - | - | - | - | 100 grains. |

Wash the paper with this solution, and dry it well near the fire in a dark room. Afterwards dip it in a solution of—

|                     |   |   |   |   |             |
|---------------------|---|---|---|---|-------------|
| Distilled water     | - | - | - | - | 1 pint.     |
| Iodide of potassium | . | - | - | - | 500 grains. |

Let it remain from three to five minutes, and then wash it well; dry it in blotting-paper, and after-

wards near the fire. All other operations are the same.

*Bingham's Process.*

36. Take

|                   |   |   |   |   |             |
|-------------------|---|---|---|---|-------------|
| Distilled water   | - | - | - | - | 1 ounce.    |
| Nitrate of silver | - | - | - | - | 100 grains. |

Pass the paper in this solution, and dry it. Pass it afterwards in a solution of—

|                     |   |   |   |   |            |
|---------------------|---|---|---|---|------------|
| Distilled water     | - | - | - | - | 1 ounce.   |
| Iodide of potassium | - | - | - | - | 25 grains. |

Drain it well, wash it, and dry it likewise. Pass it afterwards in the aceto-nitrate of silver, formed thus :

|                   |   |   |   |   |                              |
|-------------------|---|---|---|---|------------------------------|
| Distilled water   | - | - | - | - | 1 ounce.                     |
| Nitrate of silver | - | - | - | - | 50 grains.                   |
| Acetic acid       | - | - | - | - | $\frac{1}{6}$ of the volume. |

Dry it between blotting-paper, and operate as we have directed.

*Channing's Method.*

37. Pass your paper in the following solution :

|                   |   |   |   |   |            |
|-------------------|---|---|---|---|------------|
| Distilled water   | - | - | - | - | 1 ounce.   |
| Nitrate of silver | - | - | - | - | 60 grains. |

Dry it, and then pass it through a solution of—

|                     |   |   |   |   |            |
|---------------------|---|---|---|---|------------|
| Distilled water     | - | - | - | - | 1 ounce.   |
| Iodide of potassium | - | - | - | - | 10 grains. |

Wash it well in water, and dry it between blotting-paper. The paper is much more sensitive if you add to the solution—

Chloride of sodium    -    -    -    5 grains.

*Cundell's Process.*

38. Pass your paper in a solution composed thus:

Distilled water    -    -    -    1 ounce.

Nitrate of silver    -    -    -    17 grains.

Dry the paper in the air in a dark room, then take the following solution:

Distilled water    -    -    -    1 pint.

Iodide of potassium    -    -    -    400 grains.

Common salt    -    -    -    100 “

Pass the paper in this solution. The side which has received the nitrate of silver leave to dry.

*Martin's Method.*

39. For negatives:

(a) Distilled water    -    -    -    -    20 ounces.

Iodide of potassium    -    -    -    -    1 “

Cyanide of potass. (concentrated solution) 20 drops.

(b) Nitrate of silver    -    -    -    -    1 oz. 6 drachms.

Distilled water    -    -    -    -    20 “

Glacial acetic acid    -    -    -    -     $\frac{1}{2}$  “

Apply the solution (a), dry it, and pass it afterwards in the solution (b) and dry immediately.

(c) Solution of concentrated gallic acid.

(d) Alcohol.

|                      |   |   |   |   |            |
|----------------------|---|---|---|---|------------|
| (e) Rain-water       | - | - | - | - | 20 ounces. |
| Hyposulphite of soda | - | - | - | 2 | "          |

For positives :

|                     |   |   |             |            |
|---------------------|---|---|-------------|------------|
| (a) Distilled water | - | - | -           | 20 ounces. |
| Chloride of sodium  | - | - | 336 grains. |            |

|                     |   |   |   |            |
|---------------------|---|---|---|------------|
| (b) Distilled water | - | - | - | 20 ounces. |
| Nitrate of silver   | - | - | 2 | "          |

|                      |   |   |   |            |
|----------------------|---|---|---|------------|
| (c) Rain-water       | - | - | - | 20 ounces. |
| Hyposulphite of soda | - | - | 2 | "          |

To this solution you add 60 grains of nitrate of silver, dissolved in one ounce of water.

*Jordan's Method.*

40. Take iodide of silver recently precipitated, and dissolve it in iodide of potassium.

Apply this solution to the paper; dry it well, and place it upon clean water; it is then ready for use.

*Thomas's Method.*

41. Prepare the following bath :

Iodide of potassium (concentrated solution)  $2\frac{1}{2}$  drachms.

Pure iodine - - - - - 9 grains.

Dissolve it, and add—

Distilled water - - - - -  $11\frac{1}{2}$  ounces.

Iodide of potassium - - - - - 4 drachms.

Bromide of potassium - - - - - 10 grains.

Mix and filter it in a porcelain dish; place a sheet of paper on this bath, and leave it two minutes; hang it up carefully by a corner to drain.

42. The following is the bath to excite:

Distilled water - - - - - 7 ounces.

Nitrate of silver - - - - - 5 drachms.

Acetic acid - - - - - 9 “

After this, proceed exactly the same as in the wet method.

#### XI.—NEGATIVE METHOD WITH ALBUMEN.

43. Take the white of ten eggs, and dissolve in it—

Iodide of ammonium - - - - - 60 grains.

Bromide - - - - - 8 “

Chloride of sodium - - - - - 8 “

Agitate it well, and let it remain one night. Use this solution as we have indicated.

## XII.—PREPARATION OF A SPECIAL PAPER FOR PORTRAITS.

44. In a bottle make the following solution :

|                     |   |   |   |   |               |
|---------------------|---|---|---|---|---------------|
| Distilled water     | - | - | - | - | 6·200 grains. |
| Iodide of potassium | - | - | - | - | 3·10 “        |
| Cyanide             | - | - | - | - | 31 “          |
| Fluoride            | - | - | - | - | 8 “           |

Put this solution in a porcelain dish, and float the paper upon it; let it remain two or three minutes, and then dry it between blotting-paper; pass it afterwards into the bath of aceto-nitrate of silver, and leave it ten or fifteen minutes, and then operate immediately with it.

## XIII.—NEGATIVE PAPER WITH GELATINE.

45. In two pounds of distilled water dissolve 380 grains of gelatine; of this solution, take 566 grains, and to it add—

|                     |   |   |   |             |
|---------------------|---|---|---|-------------|
| Iodide of potassium | - | - | - | 202 grains. |
| Bromide             | - | - | - | 62 “        |
| Chloride of sodium  | - | - | - | 31 “        |

Pass it through a linen cloth, and immediately immerse your paper in it; let it remain in for fif-

teen minutes, and then hang it up to drain; and when dry, operate the same as on the *wet* paper.

#### XIV.—NEGATIVE PAPER WITH ALCOHOL.

##### I.

|                        |   |   |   |              |
|------------------------|---|---|---|--------------|
| 46. Commercial Alcohol | - | - | - | 2 lbs. 4 oz. |
| Collodion              | - | - | - | 155 grains   |
| Iodide of potassium    | - | - | - | 155 “        |
| Cyanide of potassium   | - | - | - | 15½ “        |

##### II.

|                              |   |   |   |   |              |
|------------------------------|---|---|---|---|--------------|
| Alcohol                      | - | - | - | - | 2 lbs. 4 oz. |
| Camphor                      | - | - | - | - | 233 grains.  |
| Varnish gum-lac with alcohol | - | - | - | - | 78 “         |
| Iodide of potassium          | - | - | - | - | 124 “        |
| Fluoride of potassium        | - | - | - | - | 31 “         |
| Cyanide of potassium         | - | - | - | - | 31 “         |

Pass your paper in this bath; dry it thoroughly; and afterwards operate exactly the same as we have said before, when speaking of the waxed paper.

#### XV.—NEGATIVE PAPER WITH THE AMMONIACO-CITRATE OF IRON.

47. Put the sheet of paper—one side only—on the ammoniaco-citrate of iron (see § 107); dry it

thoroughly in a dark room; it is then ready to expose to the light; it is very sensitive; but it is much better to add some nitrate of silver, and to use the following formula:

Water saturated with ammoniaco-citrate

|                   |   |   |   |   |   |              |
|-------------------|---|---|---|---|---|--------------|
| of iron           | - | - | - | - | - | 1550 grains. |
| Distilled water   | - | - | - | - | - | 1550 “       |
| Nitrate of silver | - | - | - | - | - | 31 “         |

PART III.

PROCESS ON GLASS.



## PROCESS ON GLASS.

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### I.—COLLODION.

#### *Cleaning the Glass.*

48. Place the glass plate on a quire of tissue-paper ; pour some alcohol, in which tripoli powder is suspended with a little ammonia. Here is the composition :

|              |   |   |   |   |   |              |
|--------------|---|---|---|---|---|--------------|
| Alcohol      | - | - | - | - | - | 3100 grains. |
| Ammonia      | - | - | - | - | - | 155 “        |
| Rotten-stone | - | - | - | - | - | 78 “         |

Rub every part of the glass with tissue-paper on both sides, and dry it well with another sheet of paper ; after which carefully polish it with a clean wash (chamois) leather ; clean the glass just before using it.

### II.—PREPARATION OF COLLODION.

49. We recommend a large bottle of collodion

to be kept on hand, unless to those who can readily procure a good article, as it will settle the better, and there need be no fear of its not keeping.

Here is the formula which we employ, and which has always succeeded well in our hands.

In a ground stoppered bottle you introduce—

|                    |   |     |                           |
|--------------------|---|-----|---------------------------|
| Rectified ether    | - | -   | 1000 parts (weight).      |
| Commercial alcohol | - | 200 | " "                       |
| Gun-cotton         | - | -   | 20 or 40* parts (weight). |
| Aqua ammonia       | - | -   | 50 drops.                 |

Agitate occasionally, and when the cotton is dissolved, add—

|                       |   |   |                   |
|-----------------------|---|---|-------------------|
| Iodide of ammonium    | - | - | 10 parts (weight) |
| Cyanide of potassium  | - | - | 1 " "             |
| Fluoride of potassium | - | - | 1 " "             |

When the salts are dissolved, filter through a cotton cloth into a bottle previously washed with ether. You can substitute for the iodide of ammonium—

|                     |   |   |                    |
|---------------------|---|---|--------------------|
| Iodide of potassium | - | - | 10 parts (weight). |
| Iodine              | - | - | 2 " "              |

The collodion has a yellow color, which after a few days becomes a light straw-color.

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\* In winter 40, in summer 20.

50. As the solution of the salts in ether and alcohol is more difficult, dissolve the salts in a few drops of water, and then add to the collodion. For immediate use, keep it in small bottles of three or four ounces each.

### III.—APPLICATION.

51. Take the glass in the left hand by the corner, and with the right hand pour the collodion in the centre of the glass; flow the collodion over the glass by a half-rotary motion. When the whole surface of the glass is covered, pour off the excess of collodion by the opposite corner, to prevent streaks; you must only pour upon the glass sufficient collodion to cover it. You place it horizontally, and you give it a gentle inclining motion from side to side. When the collodion begins to dry, immerse it in the sensitive bath.

### IV.—SENSITIVE BATH.

52. You prepare the silver bath in the following manner :

|                   |   |   |   |                      |
|-------------------|---|---|---|----------------------|
| Distilled water   | - | - | - | 1000 parts (weight). |
| Nitrate of silver | - | - | - | 80    "    "         |

You dissolve the whole of the silver in distilled water, and you then filter it, and let it repose for some hours. For this purpose you must use a vertical bath of glass or gutta-percha.

Before using the bath, filter your solution; when the bath is nearly full, you immerse the plate quickly; raise it after one minute to inspect it; it has a milky appearance, nearly white; it has also an oily appearance, which is caused by the ether.

When these phenomena have disappeared, and the glass has not the marble appearance, you remove it: allow it to drain, and then put it in the frame.

The length of time to remain in the bath of silver varies from one to three minutes. After you have prepared from five to six plates in this bath, you filter it, and from time to time add a small quantity of nitrate of silver.

#### V.—EXPOSURE IN THE CAMERA.

53. We cannot recommend this collodion as the quickest, but its success is sure; the exposure varies according to the distance and the quantity of light that you have during the experiment. With the object-glass of 18 inches, it must remain from

one to ten seconds for views, and from 30 to 40 seconds for a portrait in the shade.

## VI.—DEVELOPING.

54. There are two ways to develop :

(a) By pyrogallic acid.

(b) By protosulphate of iron.

(a) Developing by pyrogallic acid, prepare the following bath :

|                     |   |   |                        |
|---------------------|---|---|------------------------|
| Distilled water     | - | - | 100 parts (in weight). |
| Pyrogallic acid     | - | - | 1    "    "            |
| Glacial acetic acid | - | - | 10    "    "           |

When the plate is removed from the frame, you take it by one corner; cover it with the former solution; agitate well the fluid over the entire surface, being careful that the plate is entirely covered with the liquid. The image gradually appears, but it is not very distinct; you render it perfect by putting it in a bath of—

|                   |   |   |   |                  |
|-------------------|---|---|---|------------------|
| Nitrate of silver | - | - | - | 1 part (weight). |
| Distilled water   | - | - | - | 100    "    "    |

When you have attained the degree of develop-

ment wished for, you remove it, and wash it with distilled water, and then fix it. This development is preferable when the picture receives a uniform light, and the contrasts of light and shade are perfect.

(b) Developing by protosulphate of iron, you prepare the following bath :

|                       |   |   |   |                      |
|-----------------------|---|---|---|----------------------|
| Distilled water       | - | - | - | 1000 parts (weight). |
| Protosulphate of iron | - | - | - | 100 " "              |
| Glacial acetic acid   | - | - | - | 20 " "               |
| Sulphuric acid        | - | - | - | 20 drops.            |

You pour this filtered substance in a porcelain dish, and plunge the proof in immediately ; in three or four seconds the image appears, and is perfect in every part. If it has a gray tint, the exposition in the camera has been too long ; if the light parts become black, it is the contrary. If the proof has a color too light and too uniform, you could give it more vigorous tones by plunging it into a bath of gallic acid, containing a little aceto-nitrate of silver. You first drain the proof, then wash and fix it. This bath can be used a great number of times, if you filter it carefully after using it.

## VII.—FIXING THE PROOF.

55. There are two methods to fix the proof :

(a) By sulphate of peroxide of iron.

(b) By hyposulphite of soda.

(a) Fixing by the sulphate of peroxide of iron, prepare the following bath :

Distilled water - - - 1000 parts (weight).

Sulphate of peroxide of iron - 2 “ “

Wash the proof, and cover it with the former solution ; allow it to remain in this solution from fifty seconds to one minute, and then wash it with filtered water ; afterwards with distilled water ; and then dry it ; and finish drying it before a gentle fire.

(b) Fixing by hyposulphite of soda :

Distilled water - - - 1000 parts (weight).

Hyposulphite of soda - - 60 “ “

56. You operate as with the sulphate of peroxide of iron. This process renders collodion less firm than before.

Sulphate of peroxide of iron leaves a yellow opaque tint, which is very good for a faint proof.

You can also fix a weak proof with a solution of—

Distilled water - - - 1000 parts (weight).

Bromide of potassium - - 50 “ “

#### VIII.—TO TRANSFER THE NEGATIVE PROOF FROM GLASS ON PAPER.

57. Take the proof, well fixed, put it in a bath of water with a little acetic acid, and let it remain until the collodion rises from the corners of the glass; then submit it to a very gentle current of water, and continue it until the water passes under the collodion. Take two sheets of paper, put them in water, and afterwards between two sheets of blotting-paper, and then cover them carefully with dextrine; take one sheet and extend it on the proof, then the paper is adherent to the collodion. Take another glass larger than the proof, and apply it on a sheet of paper; turn the two glasses, and take out that which has the proof; the collodion then is adherent to the paper, but you see some undulations. To remove the undulations, take the second sheet of paper, and apply the side passed to the dextrine on the proof, which is then between the two sheets. Then put some blotting-paper on

the last sheet of paper, strike with the hand, and press out the excess of dextrine; then take the proof and dry it well. Wax the proof by the ordinary process, and you will then have excellent positive pictures.

### IX.—POSITIVES ON COLLODION.

58. The principal advantage positive pictures possess is, that they do not reflect like the silver-plate pictures, and they require less time to take them than negative pictures. The preparation of the plate for positives is precisely the same as for negatives, except a much shorter exposure in the camera. The pictures are developed with pyrogallic acid, to which is added a drop or two of nitric acid; or with the protosulphate of iron, and the same quantity of nitric acid. Make the solution thus:

|                 |   |   |   |   |            |
|-----------------|---|---|---|---|------------|
| Pyrogallic acid | - | - | - | - | 10 grains. |
| Acetic acid     | - | - | - | - | 65 minims. |
| Nitric acid     | - | - | - | - | 1 "        |
| Distilled water | - | - | - | - | 10 ounces. |

This is to be carefully filtered. Or thus:

|                       |   |   |   |   |            |
|-----------------------|---|---|---|---|------------|
| Protosulphate of iron | - | - | - | - | 26 grains. |
| Acetic acid           | - | - | - | - | 80 minims. |
| Nitric acid           | - | - | - | - | 2 "        |
| Distilled water       | - | - | - | - | 640 "      |

These developing solutions are so energetic, that every one who follows the directions of the books heretofore published, is extremely annoyed by the unequal action upon the surface of the plate, where the liquid first falls in pouring it over. The plan also of immersing in a vertical bath has, to a great extent, the same objection, with the greater one of preventing the judgment and taste of the operator from being exercised. To avoid this, we recommend that a glass dipper (of our style of make) be bent at a right angle, so that the handle and the hooks are perpendicular; lay on your plate, and quickly immerse it in a shallow bath, only sufficiently deep to cover the surface, and no more. This plan enables the operator to scrutinize the development as it takes place. It leaves him also with free and clean hands, which is both desirable and more comfortable. When the image is developed to your liking, remove it by means of the dipper, and immerse it in a bath of clean water, deep enough to cover the whole surface, and wash it well by frequently raising and depressing it with a gentle churning motion. In this manner the most fragile film of collodion will be removed unbroken. If the picture develops slowly, it has not been long enough exposed in the camera, and *vice versa*.

When your negative plate is dry, the last and finishing stroke is to protect it from dust and injury. This is best accomplished by varnishing it. The best varnish for this purpose is the amber varnish. This must be quickly flowed over the surface, in the same manner as described in flowing collodion, but it must be poured off again immediately. The solvent is so exceedingly volatile that it sets almost immediately. A second coat may be applied if desired; this enables the operator to wash or clean the negative plate at pleasure.

#### X.—CONVERSION OF NEGATIVES INTO POSITIVES.

59. Sir John Herschel suggested that the glass be smoked on the collodion side, backing the proof with black varnish, paper, velvet, cloth, or any other black substance. Another method is to obtain the picture by the ordinary process, that is, by collodion, and then developing by proto-nitrate of iron. After the picture is properly developed, pour over the plate, gently warmed, a solution of pyrogallie acid and partially decomposed hyposulphite of soda—definite proportions are unnecessary. The formation of metallic silver on the darkened parts renders them perfectly white and lustrous. The

velvet backing relieves the picture of that reflecting property which is so objectionable in Daguerreotypes. A solution of bichloride of mercury, or one of proto-nitrate of iron and pyrogallie acid combined, poured over the proof, will also produce gratifying results.

Probably the most satisfactory method is to use silver combined with iodized collodion. Cover the glass plate with the collodion, and immediately before it becomes dry immerse it in the following bath :

|                   |   |   |   |            |
|-------------------|---|---|---|------------|
| Nitrate of silver | - | - | - | 34 grains. |
| Nitric acid       | - | - | - | 21 “       |
| Distilled water   | - | - | - | 410 “      |

The developing is done with the sulphate of protoxide of iron, and washed with particular care, as directed elsewhere in this work.

By this proceeding, thus far we have only a negative picture. The finishing stroke is to immerse it in the following bath, to possess a beautiful and brilliant positive :

|                       |   |   |   |             |
|-----------------------|---|---|---|-------------|
| Distilled water       | - | - | - | 17 ounces.  |
| Cyanuret of potassium | - | - | - | 189 grains. |
| Nitrate of silver     | - | - | - | 31 “        |

## XI.—ALBUMEN ON GLASS.

60. Take the

|                    |   |   |   |   |              |
|--------------------|---|---|---|---|--------------|
| White of eggs      | - | - | - | - | 1550 grains. |
| Iodide of ammonium | - | - | - | - | 15½ “        |

Agitate it well and let it remain twelve hours, and then decant it. Clean your glass well, and apply the albumen the same as the collodion. Dry it in a small box, so as to keep it free from dust, &c., and then pass it into the bath of nitrate of silver, composed in the following manner :

|                   |   |   |   |   |              |
|-------------------|---|---|---|---|--------------|
| Distilled water   | - | - | - | - | 4650 grains. |
| Nitrate of silver | - | - | - | - | 372 “        |
| Acetic acid       | - | - | - | - | 465 “        |

Let it remain for two or three minutes, wash it well, and dry it in a dark room. You must develop with a warm bath of gallic acid, containing one-tenth in volume of aceto-nitrate of silver. However, it is equally as good, if not better, to develop with the protosulphate of iron in the same proportions as we indicated for the collodion.



PART IV.

POSITIVE PAPER.

THE HISTORY OF THE  
CITY OF BOSTON

FROM THE FIRST SETTLEMENT  
TO THE PRESENT TIME  
BY  
JOSEPH NEALE  
OF BOSTON  
IN TWO VOLUMES  
VOL. I.

BOSTON: PUBLISHED BY  
JOSEPH NEALE, 1789.

## POSITIVE PAPER.

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### I.—PREPARATION OF PAPER.

61. Prepare the two following solutions :

|                          |   |   |            |
|--------------------------|---|---|------------|
| (a) Chloride of ammonium | - | — | 75 grains. |
| Distilled water          | - | - | 3 oz. 60 “ |

Pour this solution into a porcelain dish.

|                       |   |   |               |
|-----------------------|---|---|---------------|
| (b) Nitrate of silver | - | - | — 280 grains. |
| Distilled water       | - | - | 3 oz. 60 “    |

Pour this solution into another dish similar to the former. Use thick paper, which you must cut to the size of your dishes. Place one side only of the paper in the bath (a), and leave it for two or three minutes; dry it well between sheets of blotting-paper. Prepare three sheets before you commence to place them in the bath of nitrate.

Take the first sheet of paper, clean it well, and place it in the bath (b), and leave it in from three to five minutes; if you leave it in a short time, you have your paper of a red color; on the contrary, if you leave it in a long time, the color is black. Afterwards dry it well between sheets of blotting-

paper. It is the best way to prepare your paper the day before using it, and, when going to use it, dry it well before a gentle fire.

When the weather is bad, you can use the negative paper, not waxed or dried for positives. Then you can develop with gallic acid. Fix with the hyposulphite of soda, for positive pictures. The picture is then slightly red; you can make it black by passing it through the following bath:

|                   |   |   |   |   |   |            |
|-------------------|---|---|---|---|---|------------|
| Water             | - | - | - | - | - | 2 lbs.     |
| Chloride of gold  | - | - | - | - | - | 15 grains. |
| Hydrochloric acid | - | - | - | - | - | 375 "      |

## II.—ALBUMENIZED POSITIVE PAPER.

62. Take white of eggs - - - 3 oz. 60 grains.  
 Chloride of sodium - - - — 60 "

Agitate it well; leave it one night, and then decant it. Pour this liquid into a porcelain dish, and prepare the positive paper as we have before indicated for negative paper; leave it in three or four minutes, and then dry it with a smoothing-iron.

Pass this paper through the following bath of nitrate of silver:

|                   |   |   |   |   |                  |
|-------------------|---|---|---|---|------------------|
| Distilled water   | - | - | - | - | 3 oz. 60 grains. |
| Nitrate of silver | - | - | - | - | — 240 "          |

Leave it in from four to five minutes. Dry it in

the same manner as we have said for the ordinary positive paper.

### III.—PRINTING THE PROOF.

63. Take your negative: place it on a glass of the frame to *reproduce*; place on a sheet of positive paper, the side which has been prepared of the negative; over all place a sheet of black paper, and the second glass of the frame; shut the frame, and leave a corner of the positive paper free, so as to see when all is finished.

Another printing process is performed in the following manner: Lay several folds of cotton flannel on the smooth surface of the ordinary printing machine (used here); then on it the sensitive paper, over which the collodion negative, held down by the springs, and expose to the rays of the sun. The hinge permits a ready inspection of the effect upon the paper.

The following are the colors which the paper takes: Gray-blue, neutral color, violet-blue, blue-black, black, black sienna, sienna, colored sepia, yellow sepia, yellow dead-leaves, and gray, until the oxide of silver becomes of a metallic substance; then you must stop.

64. If you wish to have a black proof, after the fixing by hyposulphite of soda it is necessary that the dark parts have the sepia color, and the white parts the grayish-blue color; it is exceedingly difficult to fix the time of exposure.

#### IV.—FIXING.

65. Prepare the following bath :

|                     |   |   |   |                      |
|---------------------|---|---|---|----------------------|
| Filtered water      | - | - | - | 1 lb. 2 oz. 360 grs. |
| Hypsulphite of soda | - | - | - | 3 " 60 "             |

Dissolve in it 225 grains of chloride of silver, that you have precipitated from a solution of nitrate, and agitate it well. *The older this bath is, the better.* You must not reject the black deposit which is in this bath; decant the clear liquid, and, when all is finished, pour the liquor on the deposit.

With this bath you can obtain all colors from red to black, and yellow; you must leave a proof at least one hour; sometimes it is necessary to be left three or four days.

66. You have the sienna color by adding to this bath one ounce of ammonia. You have colors very soft and yellow, if, after the fixing, you wash

the proof, and pass it through a solution composed of—

|                   |   |   |   |   |          |
|-------------------|---|---|---|---|----------|
| Distilled water   | - | - | - | - | 2 pints. |
| Hydrochloric acid | - | - | - | - | 1 ounce. |

When your proof is right, wash it well during some hours; you must leave it in water until this liquid has no sweet taste. You can fix a great many proofs in the same bath.

V.—NEW PROCESS TO OBTAIN POSITIVE PROOFS WITH  
DIFFERENT COLORS, AND VERY WELL FIXED.

67. Not long since, amateurs lamented to see the finest proofs blot, and sometimes to disappear entirely. When a proof is not solid, it is caused by the use of old hyposulphite of soda, which contains too much salts of silver. A positive proof can disappear in two ways. 1st. Because it contains some salts of silver. 2d. Because it contains sulphur or hyposulphite of soda.

The first accident is produced, 1st, by a too short time with the hyposulphite of soda; thus some chloride of silver remains in the paper, and so causes the proof to become black. 2d. By the use of hyposulphite of soda which contains too much

salts of silver: the hyposulphite of soda cannot dissolve the chloride of silver, which forms a double salt with the hyposulphite; and consequently it remains in the paper.

The second accident is produced, 1st, by the addition of an acid to the hyposulphite of soda, which is decomposed, and thus the sulphur is freed. 2d. By the immersion of too many proofs in the same bath, the quantity of chloride and nitrate of silver which is in these proofs is too considerable, —you have a disengagement of nitric acid; the bath is decomposed, and you have a precipitation of sulphur.

68. When a proof is out of the solution of hyposulphite of soda, if you do not wash it well the proof will still contain some of this salt, and the image will in consequence disappear.

By this we know that if a proof disappears, it is because it contains some salts of silver or hyposulphite.

To dissolve chloride of silver, it is preferable to use a bath of hyposulphite of soda and liquid ammonia, as in our opinion they are the best substances you can use.

69. The sulphuret of carbon and alcohol dissolve the sulphur; they ought to be used for the proofs.

The hyposulphite, with the nitrate of silver, gives a black precipitation of sulphuret of silver : before using this bath, you must transform all the nitrate of silver into chloride ; and for that purpose you can pass the proof into a bath of water containing some chloride of sodium, and afterwards wash it perfectly clean.

70. A positive proof ought to be exposed to the light a sufficient time to remain one hour at least in the hyposulphite ; this way of fixing generally gives a violet or red color. It must afterwards be washed at least four hours, changing the water every hour. If you wish a proof solid, dry it between blotting-paper, and wash it with alcohol. When you use old hyposulphite, you must remove the proof before you have the color that you wish ; pass it in water for some minutes, and then in a new bath of hyposulphite. If you wish a good proof, it is very bad to add any acid to the hyposulphite, which gives a disengagement of sulphurous acid.

If you use this process, after you have washed once you must treat the proof with alcohol, which contains half of sulphuret of carbon ; remove the sulphur by washing with alcohol alone, and afterwards wash well with water.

If you fix it with a warm bath of hyposulphite, your proof disappears, for the heat decomposes the hyposulphite. Liquid ammonia fixes very well; it gives red colors: the image fixed in this way is very solid if you wash it well afterwards.

71. With the following process, you obtain the pure black and white, the pure black, and the bluish-green. You prepare your positive paper in the ordinary way, with the chloride of sodium and nitrate of silver. You expose it to the light a longer time than when you prepare it by the ordinary process. It must have, when the proof comes out of the frame—1st, a violet color perfectly clear, and in the dark parts bluish-black in the shades. 2d. A violet color, and very black in the shades. 3d. A sepia color in the light part of a picture, that is greenish-black or bluish-green in the shades.

After exposition, wash well the proof, and put it in the following bath:

|                   |   |   |   |   |   |            |
|-------------------|---|---|---|---|---|------------|
| Distilled water   | - | - | - | - | - | 2 lbs.     |
| Chloride of gold  | - | - | - | - | - | 15 grains. |
| Hydrochloric acid | - | - | - | - | - | 1 ounce.   |

When the shades are very distinct, and all the details of the negative are visible, wash well, and then put it in the following bath:

|                      |   |   |   |   |         |
|----------------------|---|---|---|---|---------|
| Hyposulphite of soda | - | - | - | - | 1 part. |
| Water                | - | - | - | - | 6 "     |

Leave it in 30 minutes, and then wash it.

72. In using the hyposulphite containing chloride of silver, you will have some very beautiful colors, but it is good to pass afterwards in the new hyposulphite. By the addition of hydrochloric acid, you transform all nitrate of silver into chloride; and it precipitates gold and silver, and by this way the hyposulphite makes no precipitation on the white; the chloride of silver being pure, is dissolved easily by hyposulphite, which is without action on the gold. This process is not cheap, but it gives such good results, we prefer it to any other.

No care or expense ought to be spared: in order to have good pictures, we recommend this process to all.



PART V.

PREPARATION  
OF  
CHEMICAL PRODUCTS.



## PREPARATION OF CHEMICAL PRODUCTS.

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73. We give below a list of chemical products, which are mostly used in Photography.

### *Acids.*

|                        |                    |
|------------------------|--------------------|
| Acetic acid (glacial). | Nitric acid.       |
| Sulphuric acid.        | Pyrogallic acid.   |
| Gallic acid.           | Hydrochloric acid. |

### *Bases.*

|          |                 |
|----------|-----------------|
| Ammonia. | Caustic potash. |
|----------|-----------------|

### *Haloid Salts.*

|                       |                        |
|-----------------------|------------------------|
| Iodide of potassium.  | Fluoride of potassium. |
| “ “ ammonia.          | “ “ ammonium.          |
| “ “ silver.           | Chloride of sodium.    |
| Cyanide of potassium. | “ “ strontium.         |
| Bromide “ “           | “ “ silver.            |
| “ “ ammonium.         | “ “ mercury.           |
| “ “ silver.           | “ “ gold.              |

Chloride of ammonium.

*Salts.*

|                              |                         |
|------------------------------|-------------------------|
| Nitrate of silver.           | Hyposulphite of soda.   |
| “ “ zinc.                    | Hypochlorate of potash. |
| “ “ potash.                  | Acetate of ammonia.     |
| Protosulphate of iron.       | “ “ lime.               |
| Persulphate of iron.         | “ “ lead.               |
| Citrate of iron and ammonia. |                         |

*Neutral Substances.*

|             |                     |
|-------------|---------------------|
| Alcohol.    | Amylaceous matters. |
| Gun-cotton. | Sulphuric ether.    |
| Starch.     | Animal black.       |

## I.—ACETIC ACID.

Formula,  $C^2 H^4 O^2 H O = 120$ .

74. It is preferable to buy it rather than to prepare it. You ought to be sure that it is pure; to ascertain which, evaporate a certain quantity; if it is pure, no residuum is left.

Although it may not leave any residuum, still it may contain a great quantity of sulphuric acid. You can assure yourself of this by saturating a little acetic acid with potash, and pouring upon it some nitrate of baryta, or some chloride of barium. If it forms a white precipitate, insoluble in nitric acid, it is a proof that it contains sulphuric acid,

and then it is not good. It is employed in Photography, added to a solution of nitrate of silver, to facilitate the decomposition of nitrate of silver, and to assist the penetrations of the solutions into the paper. It is also employed to remove the spots on the negative proofs, formed by the oxide of silver.

## II.—SULPHURIC ACID.

Formula,  $S O^3 H O = 49$ .

75. This acid is employed only to prepare gun-cotton; that found in commerce is good enough for this purpose.

## III.—HYDROCHLORIC ACID.

Formula,  $H Cl = 36.5$ .

76. This acid is found pure in commerce. It is employed in Photography, diluted with water, to give a rich brown tone to the proof, after it has been in the bath of hyposulphite of soda. With nitric acid it forms *aqua regia*, used to dissolve gold.

## IV.—NITRIC ACID.

Formula,  $N O^5 H O = 65$ .

77. This acid can also be obtained pure in com-

merce, and we indicate the way to know if it is so. It is used in Photography to form the nitrate of silver, and, mixed with muriatic acid, it forms *aqua regia*. It turns the sulphate of protoxide of iron into peroxide. Impure, it is used to clean dishes.

To ascertain if nitric acid is pure, take a quantity of acid to test. Divide it into two parts. In one you pour chloride of barium: there should be no precipitate; if you have one, it is an indication of sulphuric acid in it. In the other, pour some drops of nitrate of silver: if you have a precipitate, it contains chlorine; if the nitric contains chlorine or sulphuric acid, it should be rejected as impure.

#### V.—GALLIC ACID.

Formula,  $C^7 H^5 O^8 = 95$ .

78. This acid is used to develop negatives on paper: with the salts of silver it gives a black color; the salts of silver lose their oxygen by the action of light. This acid precipitates all salts of silver which are in a state of suboxide. It is not useful to use it concentrated; 15 to 30 grains for a quart of distilled water are sufficient. When you

develop, it is good to add a little aceto-nitrate of silver, as it gives more intensity to the proof.

## VI.—PYROGALLIC ACID.

Formula,  $C^6 H^3 O^5 = 63$ .

79. When you have not every thing convenient for making, it is much more preferable to purchase this article than to prepare it. But you must be sure that it does not contain a particle of gallic acid. To ascertain this, dissolve a small quantity in water, and pour in it a solution of sulphate of iron; the liquor takes a very fine reddish-brown color if it contains any gallic acid. If it is impure, the color becomes blue.

## VII.—AMMONIA.

Formula,  $A^3 H^3 = 17$ .

80. Ammonia is a gas very soluble in water; this liquid dissolves about 780 times its volume of ammonia. It is possible to obtain it very pure in commerce. Ammonia dissolves the chloride of silver: if you add it drop by drop to the nitrate of silver, you will obtain a precipitate, soluble in an

excess of ammonia. This liquid is used to prepare the positive paper. Employ—

|                   |   |   |   |   |   |            |
|-------------------|---|---|---|---|---|------------|
| Distilled water   | - | - | - | - | - | 1 ounce.   |
| Nitrate of silver | - | - | - | - | - | 35 grains. |

This compound is very dangerous to use, as it produces the mixture known as explosive silver.

One property of the ammonia is, that it keeps the collodion a long time, and prevents its decomposition; a few drops of ammonia in some pounds of collodion are sufficient. This property was indicated by M. Dussauce.

Ammonia added to the bath of hyposulphite, to fix the positive proofs, gives to them a reddish-brown tint.

#### VIII.—CAUSTIC POTASH.

Formula,  $\text{K O}, \text{H O} = 56.$

81. It precipitates the oxide of silver; it is used also in weak solutions, to give a variety of tints to a proof, when it has been fixed by the hyposulphite of soda.

#### IX.—IODIDE OF POTASSIUM.

Formula,  $\text{I K} = 166.$

82. This substance is very useful in Photog-

raphy; it is used to render sensitive the collodion, paper, &c., &c. It is also used to make iodide of silver, which is insoluble in water, and soluble in the hyposulphite of soda. It is very pure in commerce.

### X.—IODIDE OF AMMONIUM.

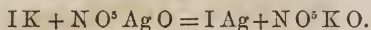
Formula,  $\text{H I Az H}^3 = 145$ .

83. This salt is used for the same purposes as the iodide of potassium, but it is more sensitive; and a proof prepared with this salt is developed easily with gallic acid for paper, or pyrogallie acid for collodion. It can be purchased very pure, but in some instances it is apt to contain carbonate of ammonia.

### XI.—IODIDE OF SILVER.

Formula,  $\text{I Ag} = 235$ .

84. Iodide of silver is obtained by the decomposition of nitrate of silver by iodide of potassium. You have the following reaction:



You must add the iodide of potassium to the nitrate of silver; wash the precipitate with water,

and dry it. The iodide of silver is soluble in iodide of potassium. This iodide is used sometimes to sensitize collodion, and to put in the positive bath for fixing positives.

## XII.—FLUORIDE OF POTASSIUM.

Formula,  $\text{FK} = 103$ .

85. This body, in small proportions, gives a great sensitiveness to the bath; and principally, when it is mixed with iodide of potassium or ammonium: in the proportion of  $\frac{1}{16}$  of iodide of ammonium in the collodion, it renders it very sensitive.

## XIII.—FLUORIDE OF AMMONIUM.

Formula,  $\text{FH Az H}^3 = 37$ .

86. Its properties are the same as fluoride of potassium, only that it decomposes very rapidly.

## XIV.—CYANIDE OF POTASSIUM.

Formula,  $\text{K Cy} = 65$ .

87. This salt, by its decomposition with the nitrate of silver, gives a combination of cyanide of

silver which is very sensitive, and it is added to iodide and fluoride of potassium to have an extreme sensitiveness. This substance dissolves all insoluble salts of silver. It can be used to clean a proof which is covered with black spots. It is used also to clean the hands; but it must be used with great precaution, for it is a violent poison.

#### XV.—CHLORIDE OF SODIUM.

Formula,  $\text{Cl Na} = 58.5$ .

88. This substance is the common salt; it is used to prepare the positive paper, and forms chloride of silver with nitrate. It is used also to obtain the chloride of silver, in mixing with a solution of nitrate of silver.

#### XVI.—CHLORIDE OF STRONTIUM.

Formula,  $\text{Cl Sr} = 134$ .

89. This compound is not very useful. You can use it if you have no other chloride. It is very soluble in water.

## XVII.—CHLORIDE OF SILVER.

Formula,  $\text{Cl Ag} = 143.5$ .

90. We have said, that in the preparation of positive paper, you employ 275 grains of chloride of silver. It is necessary to prepare this yourself; and for this purpose you take 450 grains of nitrate of silver, which you dissolve in filtered water. Pour in it an excess of solution of chloride of sodium; you will then have a white precipitate. It is necessary to pour in chloride of sodium as long as you have a white precipitate. Allow it to repose; decant the clear water. This substance is acted upon by light very rapidly. It is used to prepare positive paper, and the bath to fix the positive proofs. It is insoluble in water: acids, alkalines, cyanides, and hyposulphites dissolve it. It darkens rapidly under the influence of light: it is the most sensitive of all salts of silver.

## XVIII.—BICHLORIDE OF MERCURY.

Formula,  $\text{Cl}^2 \text{Hg} = 170$ .

91. This salt is used only to convert the negatives on collodion into positives; for this purpose

make a saturated solution of this salt in hydrochloric acid; to one part of this solution add six parts of distilled water. This salt is very good to obtain good negatives. After developing, wash it well, and pass it through the bath of bichloride of mercury; wash and fix it afterwards; the proof is blacker: by this bath it becomes positive, but the hyposulphite renews it to negative. We recommend this salt.

### XIX.—CHLORIDE OF GOLD.

Formula,  $\text{Au}^2 \text{Cl}^3 = 502$ .

92. To prepare this salt, dissolve one part of gold in four parts of *aqua regia* (one part nitric acid, four parts hydrochloric acid); evaporate it, dry it, and dissolve in water. This salt is used to obtain very fine colors, after having fixed positive proofs by hyposulphite; gold is precipitated black on silver, and gives very fine effects.

### XX.—HYDROCHLORATE OF AMMONIA.

Formula,  $\text{H Cl Az H}^3 = 54$ .

93. This salt is sold very pure in commerce. It is soluble in alcohol, and can be used very well

for positive paper, with albumen; when the paper is dry, pass it through a bath of commercial alcohol, containing five per cent. of hydrochlorate of ammonia. Its employment is preferable to chloride of sodium for positive paper, for it does not absorb water as this salt does.

### XXI.—BROMIDE OF POTASSIUM.

Formula,  $\text{Br K} = 119$ .

94. This salt is used to form the bromide of silver, insoluble in reagents. It is also less sensitive than the iodide. If you mix it with chloride of sodium, for positive proofs, you obtain them of a grayish-black color; for which use—

|                      |   |   |   |   |           |
|----------------------|---|---|---|---|-----------|
| Distilled water      | - | - | - | - | 10 parts. |
| Bromide of potassium | - | - | - | - | 1 "       |
| Chloride of sodium   | - | - | - | - | 1 "       |

It is used also to fix negative proofs; but for this purpose the hyposulphite is much better.

### XXII.—BROMIDE OF AMMONIUM.

Formula,  $\text{Br Az H}^3 = 97$ .

95. The use of this salt is about the same as the

bromide of potassium. Dissolved in water, it forms an excellent bath to fix positives.

|                     |   |   |   |   |            |
|---------------------|---|---|---|---|------------|
| Distilled water     | - | - | - | - | 100 parts. |
| Bromide of ammonium | - | - | - | - | 100 "      |

Leave your proof half an hour, and wash it well afterwards.

It can be used also for negative and positive paper. The best formula is as follows :

|                     |   |   |   |   |             |
|---------------------|---|---|---|---|-------------|
| Water               | - | - | - | - | 1000 parts. |
| Iodide of potassium | - | - | - | - | 15 "        |
| Bromide of ammonium | - | - | - | - | 4 "         |
| Sugar of milk       | - | - | - | - | 40 "        |

### XXIII.—BROMIDE OF SILVER.

Formula,  $\text{Br Ag} = 188$ .

96. You obtain it by the decomposition of nitrate of silver by cyanide of potassium; it is a very sensitive salt, but less so than the iodide.

### XXIV.—NITRATE OF SILVER.

Formula,  $\text{N O}^3 \text{ Ag O} = 270$ .

97. In a porcelain dish put a piece of silver coin; pour upon it an excess of pure nitric acid. The

reaction is almost immediate, and violent; when it is nearly dissolved, warm the liquid; when all is dissolved, evaporate to dryness; fuse or melt, so that the nitrate of copper will be decomposed; redissolve it, and filter. The solution of nitrate of silver is evaporated to dryness; fuse and flow, that is, pour it on a clean surface of porcelain: then the salt is very pure. It is used to obtain all insoluble salts of silver, iodide, chloride, &c., &c. It is much better to use it fused, as, when crystallized, it always contains a little acid; it is impossible to obtain it crystallized without its having acid in it.

## XXV.—NITRATE OF ZINC.

Formula,  $\text{Zn O N O}^s = 94$ .

98. You obtain this by dissolving zinc in nitric acid, and evaporating the solution.

Added to the bath of aceto-nitrate of silver, it augments sensitiveness; and by the precipitation of the oxide, it forms a size for paper. To prepare it as a size for paper, make the following bath:

|                 |   |   |   |   |            |
|-----------------|---|---|---|---|------------|
| Distilled water | - | - | - | - | 100 parts. |
| Nitrate of zinc | - | - | - | - | 6 "        |

Pass your paper through it; dry it, and operate as we have before indicated.

### XXVI.—NITRATE OF POTASH.

Formula,  $\text{N O}^{\circ} \text{K O} = 101.$

99. It is used only to prepare gun-cotton. As it is found in commerce, it is very pure. For this purpose it ought to be well pulverized.

### XXVII.—HYPOSULPHITE OF SODA.

Formula,  $\text{S}^{\circ} \text{O}^{\circ} \text{Na O} = 124.$

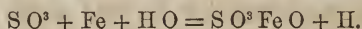
100. It is found pure in commerce. It is very much used in Photography, to dissolve insoluble salts of silver. But when you use it, care must be taken that the liquids are not acid, for they decompose the hyposulphite, so that the sulphur is freed, and gives to the proof a gray dirty color. It is used to fix both negatives and positives.

### XXVIII.—SULPHATE OF PROTOXIDE OF IRON.

Formula,  $\text{S O}^{\circ} \text{Fe O} = 76.$

101. To be sure to have this body to the minimum of oxidation, it is much better to prepare it

yourself; for this purpose, in a small matrass of glass, introduce some water, iron (in powder), and sulphuric acid. Reaction takes place without heat; when the reaction subsides somewhat, you must warm it. It is necessary to have an excess of iron. The following is the result of the chemical reaction :



The water is decomposed; the oxygen unites with the iron to form protoxide of iron, which combines with the sulphuric acid to form sulphate of protoxide of iron, the hydrogen being disengaged. Filter the solution; evaporate it from the contact of air, and it will crystallize. It is necessary to prepare only a small quantity at a time, as it is transformed by the air into persulphate.

#### XXIX.—PERSULPHATE OF IRON.

Formula,  $3 (\text{S O}^3) \text{Fe}^2 \text{O}^3 = 200.$

102. To obtain this salt, treat the sulphate of protoxide of iron by nitric acid; evaporate and dry it, until you have no nitric acid. This salt is used to fix negatives on glass.

## XXX.—HYPOCHLORATE OF POTASH.

Formula,  $\text{Cl O K O} = 88.5$ .

103. You can get this article pure in commerce. It is used to clean paper. For this purpose, add to it the half of its volume of water. It also fixes positive proofs.

## XXXI.—ACETATE OF AMMONIA.

Formula,  $\text{C}^4 \text{H}^4 \text{O}^4 \text{Az H}^3 = 80$ .

104. It accelerates the developing of negative proofs on gallic acid, and continues the reduction which is begun by the light; but it is dangerous to use it, for sometimes its action is so rapid, that it destroys all the proofs.

## XXXII.—ACETATE OF LIME.

Formula,  $\text{C}^4 \text{H}^4 \text{O}^4 \text{Ca O} = 129$ .

105. United with gallic acid, it is used to develop very quickly. It decomposes iodide of silver, and forms acetate of silver and iodide of lime, after the oxide of silver is reduced and pre-

cipitated black. This salt also has a too rapid action.

### XXXIII.—ACETATE OF LEAD.

Formula,  $C^4 H^6 O^6 Pb O = 181.6$ .

106. Its use is the same as acetate of ammonia and lime, but it is not so dirty; added to hyposulphite, it is used to fix positive proofs. From 5 to 25 parts of this salt for 100 parts of hyposulphite, you obtain red, violet, or black colors.

### XXXIV.—AMMONIACO-CITRATE OF IRON.

107. Take citrate of ammonia; put into it some iron powder; leave to evaporate, filter, and then evaporate to dry. This solution is sensitive. We have seen it used with paper.

### XXXV.—ETHER.

108. The ether employed ought to be anhydrous; that is to say, it ought to have been rectified with lime. Put into the ether a piece of blue litmus paper, so as to be sure it is not

acid. If the paper becomes red, it must not be used, for the collodion will be destroyed in a short time.

### XXXVI.—ALCOHOL.

109. The alcohol found in commerce of 95 per cent. is good enough, if it contains no acid.

### XXXVII.—GUN-COTTON.

110. Take 300 grains of dried nitrate of potash, in fine powder; introduce it into a mortar, and pour on 600 grains of sulphuric acid. Mix it well; and gradually immerse 75 grains of pure cotton; leave the cotton in a quarter of an hour; remove to a funnel, and wash it well with lukewarm water. When the cotton is free from acid, wash it well three or four different times with distilled water. Dry it in a proper temperature, covered with filtering paper, to keep off the dust. If during the process red vapors are evolved, the cotton is good for nothing, and a new portion must be prepared.

## XXXVIII.—PURE COTTON.

111. Take wadding, and treat it—1st, with a solution of weak potash. 2d. With water. 3d. With hydrochloric acid. 4th. With boiling distilled water, and dry it.

## XXXIX.—ANIMAL BLACK.

112. It is found very pure in commerce. It is used to purify the old bath of aceto-nitrate of silver, and it gives more sensitiveness to the bath, because it forms phosphate of silver, which is soluble in acetic acid. There is a great difference between the baths; one with animal black, and the other without; the one with the animal black being very sensitive, while the other is not.

## XL.—STARCH AND OTHER AMYLACEOUS AND FATTY MATTERS USED FOR NEGATIVE PAPER.

113. Starch is soluble in boiling water, and becomes insoluble in cold water, when it is dried. The best way to obtain this starch, is to use rice-

water. Starch forms with iodine a compound which has a bluish color.

A warm solution of gelatine applied on paper with iodine, gives a size to paper, which is insoluble in cold water.

Albumen is also very good to use for this property, as it becomes insoluble in water when it is warm.

Inuline is also very good, because it is insoluble in cold water, although it is very soluble in hot.

Resins, camphor, &c., &c., are also very good in solution of alcohol, and by insolubility in water. It is the same for collodion.

In general, to have a good size, you must employ a substance soluble in the liquid used to dissolve the other preparations, and after which it becomes insoluble in the other preparation.

The sugar of milk is very good : to prepare it, concentrate the whey ; when the liquid becomes cold, it deposits crystals, which are the sugar of milk.

Dextrine is the starch treated by a solution of sulphuric acid and water : its only use is to transfer a proof on paper.

114. Such are the chemical products used in Photography. We hope that everybody will find in this part of the work all the information necessary for the use and tests of the chemicals and their reactions.

PART VI.

THE APPARATUS, FOCUS,  
AND  
THEORY OF THE PHOTOGRAPHIC PHENOMENA.



## THE APPARATUS.

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115. THE simple camera obscura, invented by Porta, in the year 1650, served for photographic experiments as long as the art remained in its infancy ; but as the art progressed, it was soon found that this instrument was too imperfect to satisfy the increasing demands made upon it. A great many improvements were made in the camera by the combined exertions of Petzval and Voightlander. But even this improved camera is by no means every thing that could be desired. The demands that may be justly made upon an apparatus, truly deserving the name of perfect, are as follows : It must give a large-sized picture, correctly drawn, and equally distinct in all parts : it must command a most intense light, and it must be adapted equally for portraying, and for taking views of architectural objects. Now, up to the present time, the problem of fulfilling all these conditions

equally, has not been solved ; indeed, one excludes the other. If the picture is to be large, of equal clearness and distinctness in all parts, even to the border, and equally so for near objects as for those farther off, the focal distance must be proportionately longer, and the aperture through which the luminous rays enter must be smaller. The necessary consequence of this mode of construction is, that the apparatus does not command a sufficiently intense light to answer the purpose of taking portraits with it. On the other hand, if the focal distance is lessened, and the aperture enlarged (with the best suited to the purpose), the apparatus will then command a greater amount of light, and will accordingly be better adapted for the taking of portraits. But it will be found that this has been achieved only at the expense of the size of the picture, and of the desired correct delineation, and equal clearness and distinctness in all parts.

116. An apparatus so constructed, is therefore but imperfectly adapted for taking views of landscapes or of architectural objects ; and although small views may, if need be, be taken with it, by placing screens before it to reduce the aperture, the productions so obtained are very inferior to the views taken with an apparatus of greater focal dis-

tance and smaller aperture. This applies more especially to pictures taken on paper; since from the unequal texture of that material, the minute details of the object delineated will necessarily grow indistinct and confined, or even vanish altogether if the surface acted upon is too restricted to reflect these details on a sufficiently large scale.

The duty of the optician consequently is, to construct and combine the apparatus in such a manner as to produce the best total effect in every individual case, which of course requires, in the first place, due attention to the choice of curvatures in the lenses, as on this principally depends the accuracy of the impression. A proper achromatization of the glasses will obviate the occurrence of colored edges in the images taken. The glass for the lens ought to be as white as possible, and pure and even throughout, — requirements which it is not always easy to fulfil. Perfect whiteness is not, however, absolutely necessary; on the contrary, a violet tint of the glass is rather desirable than otherwise, provided the coloration be not too intense, since this would tend to lessen the luminousness of the apparatus, more particularly with larger lenses, on account of the greater thickness of the glass. There are not unfrequently little

bubbles and small black spots in the vitreous mass ; however, if there are not too many of them, nor over-large ones, their presence matters little, as may be readily proved by a simple experiment : Cut a small round piece of paper, and paste it with gum on the object-glass in the centre : a picture taken with this glass will show no difference from another taken with a clear glass ; at the most, the time of exposure may require to be prolonged a little ; that is, if the piece of paper pasted on the object-glass is of rather large size in proportion to the aperture. But the glass must be free from tears ; and, indeed, no conscientious optician will knowingly make use of glass having tears, which requires a practised eye to detect. Still, even with glasses of this kind, an apparatus, otherwise properly constructed, is preferable to one with faultless glasses, but with a defective combination of the lenses ; the defect caused by tears being, after all, imperceptible in the miniature picture of the camera, or, at all events, scarcely visible to the naked eye.

To be able to pronounce a correct opinion on the quality of a photographic apparatus, the one thing needful is to take a picture with it, in two apparatuses of the same construction : that one is the

best which produces the larger picture of the two, of equal or superior distinctness, and in the shortest time.

Besides the quality of the object-glass, and the proper fixing of the chemical focus (of which we shall treat in the next section), the accurate adjustment of the apparatus also forms an essential condition for the good success of photographic operations. The prepared side of the plate or paper, on which the image is to be produced, must be placed exactly in the spot previously occupied by the roughened side of the ground-glass plate or focusing glass (the side turned towards the object-glass); if it is not made to occupy that exact position, the clearness of the impression produced will suffer in proportion to the extent of the deviation from it.

117. The construction that has been given to the camera obscura, and to the frame for the reception of the plate or paper, varies greatly; however, all the modifications introduced have essentially one and the same object in view, namely, the facilitating of certain manipulations.

In Voigtlander's apparatus, the camera consists of a large cylindrical brass tube; in others it is a square wooden box; the latter again varies greatly in size, and in the arrangement of the details of

construction. But they all agree in this point, in having the object-glass set in the anterior part; the roughened or unpolished glass-plate or focusing glass (for which is substituted the frame carrying the plate or paper) being placed in the posterior part. One of the great advantages of this apparatus of Voigtlander's is, that when taken to pieces and packed in a box, it occupies only a small space, and may consequently be readily carried about, which makes it very convenient for travelling purposes. Moreover the material of the apparatus being brass or metal, there is no fear of absorption of iodine or bromine, or of aqueous vapors. On the other hand, this apparatus has also its drawbacks: the plates at present in use being square, the edges must necessarily be cut off, to fix them for the round frame; moreover, the apparatus requires repeated moving in the course of every operation, and the naturally low temperature of the metal demands a longer exposure of the plate.

The construction of the camera which is even at present most generally used, differs from the preceding principally in this, that the large brass cylinder is replaced by a square wooden box.

This power of lengthening or expanding the camera, is an advantage which Voigtlander's ap-

paratus does not possess. If it is intended to take very small pictures with the latter apparatus, the camera must be removed to a great distance from the object to be portrayed; and this is in many cases difficult, and in others altogether impracticable.

118. There exists a camera of a different construction, which combines all the advantages of this camera: it consists in the stretching a bag of cloth or caoutchouc, and in the simple way in which the paper or plate may be adjusted to any angle which may be thought adapted to obtain a good focus. Another advantage is the vertical mobility of the object-glass, whereby the object to be portrayed may readily be brought into the centre of the field of vision. The posterior part of the apparatus is fastened to a movable plate, which may be screwed fast on to the ground-board, at a longer or shorter distance from the object-glass; by which means the operator is enabled to employ, if need be, object-glasses of different focal lengths. The whole apparatus is so arranged, that it may be readily folded and packed. It weighs only half as much as a common camera; and when carefully packed up, occupies only half the space taken up by the latter.

Instead of, and even in preference to the cloth or caoutchouc bag camera, one of pasteboard may also be used, made in the same shape as the bellows of an accordion. As this camera can be lengthened without the intervention of a sliding-box, it is peculiarly adapted for copying pictures in enlarged or reduced sizes. To do the former, and especially to copy enlarged positive pictures from small negatives on glass or paper, another camera, of the same size and construction, is necessary, which is fastened quite tight to the object-glass of the first camera, so as to place the object-glass between the two. The negative picture to be copied is put into the frame in the back of the second camera, which is then so placed that the direct light falls through the negative picture. In the frame of the first camera is placed the plate or paper intended to receive the positive impression of small size; and fitting accordingly in a limited compass, may be taken on the journey, and may then at leisure be transferred, in larger size, to positive plates or positive paper. The operation of copying is conducted in exactly the same manner as the original taking of the negative impression.

The development of the positive picture is effected in the usual manner.

119. There is still another camera of a different construction, used more particularly in England and France for taking views of landscapes, and to which the name of "traversing camera" has been given. The peculiar feature of this camera consists essentially in this, that with a comparatively small and different object-glass, it produces pictures of considerable size, accuracy, and clearness. Thus, with an object-glass of common quality, views are obtained fourteen inches long by four and a half inches wide, and which are perfectly clear and distinct throughout, and embrace a field of vision (horizon) of more than one hundred and fifty degrees.

120. The arrangement by means of which this result is obtained, consists in the main—1st. In a horizontal motion imparted to the object-glass by rack-work, and which causes it to traverse successively all the points of the horizon. 2d. In the cylindrical incurvation which the paper or plate is made to assume by means of a groove in the camera. As the paper by itself would not retain the curved position given to it, it is placed mostly on a metal plate, to which it readily adheres, and its incurvation is thus insured during the operations: by this contrivance, objects, at however

unequal distances from each other, are transferred to the plate or paper at the same focal distance, and without displacing the camera. 3d. In a small vertical aperture in the bottom of a kind of box, which accompanies the object-glass in its motion. This aperture, which supplies the place of a diaphragm that would occupy a position in the rear, brings to bear upon an excitable surface only the ray in the centre—those rays only which have no sensible alterations. This tends, of course, materially to increase the distinctness and accuracy of the impression.

The position of the turning axis of the object-glass must be fixed with the greatest precision, otherwise the images of the objects towards which the apparatus is successively turned, would, ere they become extinct and give place to the succeeding ones, move on the depolished glass, and accordingly also on the plate or paper, which of course would destroy the clearness of the image.

To hit the proper position of the axis to the object-glass, the tube of the latter need simply be pushed in more or less, until perfect immobility of the images is attained.

## THE FOCUS.

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121. It is a remarkable fact, and one which must never be lost sight of in photographic operations, that the rays which possess the greatest luminousness do not likewise exercise the greatest chemical action. Therefore, even with the adjustment of the apparatus giving a perfectly clear and distinct image of the object, and with the most rigorously exact placing of the photographic plate or paper, there are still certain accessory conditions required to obtain a perfectly correct impression.

The rainbow colors of the white ray, refracted through the prisma, are seen side by side on the surface on which they are thrown: now in the camera obscura, these colors or rays lie, properly speaking, behind one another, and cover each other, so that they appear to the eye as one—coinciding all of them in the yellow ray, as the most intense of them; it is accordingly to this ray that the optical focus of the camera obscura is adjusted.

But the yellow ray is not the one possessed of the most energetic chemical action ; it is the violet ray in which the chemical force and influence of light chiefly resides : the plate or paper intended for the reception of the image, must accordingly be placed in the focus of the latter ray. Now, as the length of each ray depends partly on the radius of the curvature of the lenses, partly on the refractive power of the vitreous mass, and partly also on the distance of the object from the object-glass, it follows that every object-glass must be specifically tried and tested to determine the difference between the optical and chemical focus.

122. In non-achromatic lenses, the point of conveyance of the violet rays, and accordingly the chemical focus, lies usually nearer to the object than the optical focus, which difference decreases, however, in proportion to the distance of the object from the apparatus. In this case, therefore, the camera must be shortened, which is effected most simply, by moving the object-glass backwards.

But the case is different with achromatic lenses ; here no general rule can be laid down, but every object-glass must be submitted to a separate careful trial. Various apparatus and contrivances have been devised to determine the chemical focus of an

object-glass ; but the simplest and easiest way of all, is the following, recommended by Professor Varrentrap :

123. Place nine books, with printed titles on the back, perpendicularly side by side, at a certain distance from the object-glass, in such a manner that the second stands an inch further back than the first, the third than the second, the fourth than the third, and so on for the rest. Place and adjust the apparatus so that you see the titles on the backs of the books reflected in the glass plate, with the printing on the back of the *fifth* in the row appearing the most distinct in the nine, which may be readily and accurately discerned. Now, take a picture with the apparatus so adjusted, and without displacing it. The degree of accuracy and distinctness possessed by the picture will enable you to fix upon the proper adjustment of the apparatus. Opticians have indeed endeavored to supply object-glasses through which all the rays should converge in one point ; in this they have, however, succeeded only for certain distances.

124. There is another way of arranging the matter, viz., by employing glasses that intercept those rays of which the chemical action is but little energetic ; or, in other terms, those rays which coun-

teract the chemical effects of the violet ray ; the principal among these rays is the yellow. True, this means involves a certain loss of light, which however is amply compensated by the increased energy of the chemical action, and the greater certainty in the performance of the process.

As it is, however, rather difficult to procure glasses of the above kind, another way still may be recommended, namely, to place before the object-glass a very thin violet-colored glass, ground to exactly the same curvature as the object-glass.

This contrivance, which fully answers the purpose, may be readily applied to object-glasses of all kinds.

## THEORY OF THE PHOTOGRAPHIC PHENOMENA.

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125. IF we inquire the nature of the action of light in the production of the photographic phenomena, we find that the effects produced arise from the decomposing action which light exercises upon metallic compounds, tending to reduce them to the metallic state. In the case of iodized silver plates, the following appears to us the rational explanation of the phenomena observed.

The iodine of silver formed on the plate in the iodide-box, is reduced by the action of the luminous rays to subiodide—the liberated iodine being again absorbed by the plate. This reduction is most considerable in the most strongly illuminated parts; in the less illuminated parts, it is much less marked; and in the darkest parts the iodide of silver is hardly affected at all. Now, upon the subsequent contact of the mercurial fumes with the surface of the plate, the mercury combines with the

iodine of the iodide of silver, forming subiodide of mercury, with a corresponding reduction of silver to the metallic state. The quantity of the subiodide of mercury so formed, is greatest in the shaded parts, where the iodide of silver is left almost intact; less in the parts feebly affected by the luminous rays; and least in the parts where the action of the light has been strongest. As regards the shaded parts, the chemical action stops here; but the case is different with the parts previously acted upon by the luminous rays. In these latter parts, the subiodide of mercury formed coming into contact with the subiodide of silver, a double decomposition ensues: the subiodide of mercury separates into two parts, of which one combines with the iodine of the subiodide of silver, and with the iodine of the other part, forming iodide of mercury; the reduced silver and the reduced mercury amalgamating and settling on the plate. The picture accordingly makes its appearance first in the lightest parts, since the quantity of mercury absorbed is the greater the richer the parts are in subiodide of silver. In the most shaded parts, on the other hand, where iodide of silver alone is offered to the mercurial fumes, there can be formed only a more or less dark film of subiodide of mer-

cury, mixed with metallic silver ; which latter substance, being in a state of most minute division, exhibits a black tint. But between these two extremes of the deepest shadow and the strongest light, are seen the semi-tints of the object depicted ; and these semi-tints again are lighter or darker in the different parts of the picture, in proportion to the depth of the film of subiodide of silver respectively covering the several parts, and accordingly in proportion as the iodide has been acted upon more or less vigorously by the luminous rays ; and thus we find also, after the exposure of the plate to the mercurial fumes, that the shaded parts, being covered with iodide of mercury and metallic silver, look black or greenish ; whereas the lightest parts look reddish, from the presence on them of an alloy of silver and mercury, in invisible particles, covered with a film of iodide of mercury. Upon washing the plate afterwards with a solution of hyposulphite of soda, the iodide of mercury is dissolved ; the subiodide being decomposed at the same time into iodide, which is then also dissolved, and metallic mercury remains on the plate. The white parts of the picture are accordingly constituted by the alloy of mercury and silver deposited on the plate, and are the more vivid the more

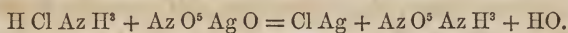
copiously this alloy has been deposited ; the dark parts, on the other hand, are formed by deposits of most minutely divided metallic silver. The production of photographic pictures on paper or glass, is likewise the result of the decomposition, by the agency of light, of the metallic compounds forming the impressionable surface ; of this fact, anybody may convince himself by the following simple experiment :

126. Take a piece of paper, prepared with chloride of ammonium and nitrate of silver, and put it, together with a little potassium, into a perfectly dry glass tube ; seal this hermetically, and leave it about twenty-four hours in the dark, to give time for the oxygen of the air in the tube to combine with the potassium. Place the tube now in sunlight : after a few hours you will find that the paper has acquired a black tint, though not of the same intensity as another piece of the same paper, which has been exposed for a much shorter time in the open air.

If you now open a glass under a solution of ammonia, you will not indeed detect any free chloride in it ; however, if you examine the potassa salt in the glass, you will find that it is the hydrochlorate, —an evident proof that hydrochloric acid must

have been liberated from the paper, and have combined with the alkali metal.

127. The several processes of decomposition and combination which have taken place, may be briefly stated as follows: The paper having been prepared with chloride of ammonium and nitrate of silver, we have in it—



128. There are accordingly contained in the paper, nitrate of ammonia, chloride of silver, and water; and besides these substances, a little free nitrate of silver, as has been intimated already on a former occasion. Under the influence of the solar rays, the chloride of silver is decomposed,—the liberated chlorine probably combining with the hydrogen of the decomposed water, and forming hydrochloric acid with it; whilst the potassium combines with a portion of the liberated oxygen of water, forming potassa; which again combines with the hydrochloric acid, to form hydrochlorate of potassa; the liberated silver of the chloride combines with the other portion of the oxygen, to form oxide of silver.

129. The liberation of the chlorine may be equally demonstrated by another very simple ex-

periment: Put a little pure chloride of silver into a bent glass tube, closed at one end, and confine the other end under water; expose the chloride in the tube to light, taking care to shake the tube occasionally, in order that the whole of the chloride may be brought under the influence of that agent. As soon as the chloride of silver begins to acquire a black tint, the water will be seen to rise in the tube. When the whole of the chloride has become black, add a few drops of solution of nitrate of silver to the water, when the formation of a precipitate of chloride of silver will at once demonstrate the presence of chlorine in the water.

This simple experiment sufficiently shows that the chloride of silver suffers decomposition under the influence of light,—chlorine being set free, and the reduced silver combining with oxygen instead.

130. The same explanation of the process applies equally to the iodide and bromide, and the other salts of silver. The use of gallic acid to develop the latent image, rests upon the great affinity of that acid for oxygen, by virtue of which it decomposes the salts of silver; properly speaking, therefore, this acid simply serves to complete what the

light has already begun. The action of the light has tended already to loosen the connection between the component elements of the silver salt, in the parts touched by the luminous rays: in these parts, therefore, the gallic acid readily succeeds in reducing the silver to the metallic state—the minutely divided reduced silver exhibiting a black tint,

In the parts that have not been acted upon by the light, on the other hand, the silver salt has remained unaltered; and the gallic acid cannot, therefore, effect the separation of metallic silver here so rapidly as in the parts impressed by the light. Now, upon treating these pictures afterwards with hyposulphite of soda, the unaltered salt readily dissolves in this agent, and is thus removed; whereas, the separated silver is but very little affected, and remains in the substance of the paper in a state of minute division; the picture appears accordingly negative (that is, if produced in the camera in the usual manner). Instead of gallic acid, other substances that have a strong affinity for oxygen, such as hyposulphite, sulphite, and hyponitrate of protoxide of iron, may be used with the same result; also the alcoholic solution of many ethereal oils, more especially of the oil of

cloves (*oleum caryophyllorum*), and of cinnamon (*oleum cinnamomi*); these latter, however, act much more slowly than the other substances named.

131. In the case of the salts of iron, the impression produced by the decomposing action of the light, is brought out most fully and clearly by subsequent treatment with ferricyanide of potassium.

132. We give a few practical hints on the proper selection and arrangement of the *locale* in which photographic operations may best be performed, and on the proper posture, attitude, and dress of persons who wish to have their portraits taken with the photographic apparatus.

Photographic portraits are, of course, always taken best in the open air. However, as it is not at all times feasible to do so, the photographic artist must select and suitably arrange an appropriate apartment for the purpose. It need hardly be remarked here, that this apartment must be as light as it is possible to get it; in fact, the most suitable is a glass house, standing in an open ground, or erected on the top of a building. But here, again, every one has not the means at his command to have a structure of the kind erected

in an appropriate spot. Most photographic artists must content themselves with the choice of a well-lighted apartment, if possible with a skylight. A room receiving the light from the northwest, is preferable to others.

The walls should be painted of a light blue, which will tend to diffuse a mild, uniform light throughout the apartment. In the case of a glass house, the light may be regulated in the same manner by means of light-blue curtains. This contrivance has another beneficial effect; namely, it excludes those luminous rays which are least effective in a photographic point of view.

As regards the proper attitude of the person sitting for the portrait, this must of course be left, in a measure, to the individual judgment and taste of the artist. However, a few hints on this subject may not prove unwelcome.

133. The posture of the person sitting for the portrait, should be easy and unconstrained; the feet and hands neither projecting too much, nor drawn too far back; the eyes should be directed a little sideways above the camera, and fixed upon some object there, but never upon the apparatus, since this would tend to impart to the face a dolor-

ous, dissatisfied look. Stout persons should be placed at a certain distance from the apparatus, turning towards it a little sideways; whilst people of slender make should be made to sit full in front and nearer the apparatus. Long arms and legs require drawing back a little. The hands should rest easy on the lap, neither too high nor too low; or one hand may be placed on the table, the other holding a book or some other object. A thick hand should show the thumb in the foreground, with the fingers bent a little inward; a long hand had better show the back; a hand of handsome shape, neither too long nor too short, should show full two-thirds, with the fingers easily and gracefully hanging down. A slight lateral inclination of the body forward will generally produce a good effect. In the case of ladies, a shawl or boa, or similar article of dress, thrown lightly over the shoulders, and arranged in a manner to hide some defect, and to properly distribute light and shadow, will mostly tend to produce a pleasant impression.

Of a full round face, with large mouth, small eyes, and small nose, the portrait should be taken in half profile, so as to show one side of the face in full, with very little of the other side.

A moderately full face, with aquiline nose, and handsome mouth and eyes, should be taken in three-fourths profile ; a countenance with strongly marked features full in front.

The selection of a proper background for the picture, is also a matter of some importance. In some cases, a landscape will give a most pleasing background ; in others, a simple wall will answer as well, or even better : the decision here must be left to the individual judgment and taste of the artist.

If two persons are to be portrayed in the same picture, the one should be made to lean lightly on the chair of the other, and the faces of both should be partly turned to each other, as in conversation. Or they may be placed at a table, seated opposite each other, the one with the right, the other with the left arm laid on the table, and the bodies of both gently inclined forward and towards each other, as in conversation.

The arrangement of family groups, again, must be left entirely to the judgment of the artist. Care should always be taken, however, to place the several persons constituting the group, all at the same focal distance.

134. With respect to dress, colors and objects of

intense illumination should always be avoided : this applies more particularly to yellow and scarlet. Plain-colored dresses, neither too light nor too dark, give always the most pleasing pictures.

## TO PREPARE PHOTOGRAPHS FOR COLORING.

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135. PHOTOGRAPHS designed to be colored in water-colors, need no preparation other than to be carefully mounted on thick Bristol paper with gum-water.

But for oil painting, they require to be mounted upon millboards or canvas, and thoroughly oiled previous to the putting on of color. Great care should be taken in pasting them upon the canvas, so that they may dry smooth and present an even surface. This may be done by smoothing them over, while the paste is wet, with a soft rag or some cotton. Almost any kind of paste may be used for this purpose, but the most convenient is a solution of gum-arabic, made very thick.

The most expeditious method of preparing photographs for oil-color, is to saturate the paper with megilp (a mixture of boiled linseed oil and mastic varnish), after it has been mounted and the paste become dry. The color may be applied at once, and worked into the megilp, or the whole allowed to dry. The latter will probably be found to be

the better plan, as the color will hold better, and work easier when the preparation is dry and hard. Photographs prepared in this manner are colored in the regular style of portrait-painting, and require an artist of some experience to do them successfully, owing to the difficulty of preserving the drawing, &c.

Another and an easier way, is what is called the "transparent coloring" (by applying the color upon the back of the photograph). The photograph is first dipped in linseed oil, then laid upon a piece of glass, and colored upon the back. A very fine effect is sometimes produced in this manner; and the operation being exceedingly simple, is capable of being performed by persons of little or no experience in painting. In this case the picture is not to be mounted until painted. A very excellent substitute for oil in preparing photographs for this style of painting, is the Canadian Balsam, which has the property of rendering the paper very transparent, and dries much better than oil.

[We are indebted for the above article to Mr. Estes, an excellent young artist, of 609 Broadway, who has had considerable experience in coloring photographs.]

EXPLANATIONS  
OF  
SOME OF THE CHEMICAL TERMS

*Which occur in the present work ; intended for the benefit  
of persons unacquainted with Chemistry.*

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136. CHEMISTS divide bodies into simple and compound. The simple bodies are also called elements, or elementary substances. These terms, however, by no means imply that the bodies so called are really simple or elementary ; but simply that they appear to us so at the present time, having hitherto resisted all attempts to decompose them.

The elementary substances at present known to us, amount to sixty-three in number. They are usually divided into two great classes, viz., metals and non-metallic bodies, or metalloids. This division is, however, entirely arbitrary, as the two classes completely merge into each other. The

class of metalloids comprises fifteen elementary bodies; however, in the present work we have given only thirteen of them, viz., Arsenic, Boron, Bromine, Carbon, Chlorine, Fluorine, Hydrogen, Iodine, Nitrogen, Oxygen, Phosphorus, Selenium, and Sulphur. The class of metals comprises forty-seven simple bodies, of which we have only given twenty-four, viz., aluminium, antimony, barium, bismuth, calcium, chromium, cobalt, copper, gold, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, platinum, potassium, silver, sodium, strontium, tin, uranium, and zinc.

137. Every elementary substance is designated in chemical notation by the initial of its Latin name in capital; or, where the names of several substances begin alike, by the first letter conjoined with a second small one—the most characteristic in the word. This simple or compound letter-mark is called the symbol of the substance; it designates not only the substance in the abstract, but represents one equivalent of it.

Thus, *e. g.*, Hg (from the Greek hydrargyrum) represents one equivalent of mercury; Fe (from the Latin ferrum), one equivalent of iron; O, one

equivalent of oxygen; H, one of hydrogen; Ca, one of calcium, &c.

The compound bodies result from the union of two or several elementary substances. The combinations of metals with each other are called alloys; or, where mercury is one of the constituent elements, amalgams. The metalloids combine with each other, and, with the metals, forming bases, acids, and salts. Thus, for instance, the metalloid chlorine combines with hydrogen, forming the well-known muriatic acid, which is more commonly called by chemists hydrochloric acid; chlorine combines also with the metal sodium, forming common salt (chloride of sodium); oxygen combines with the metal potassium, forming the well-known alkaline base, potassa, &c. The combination of bases with acids, gives rise also to the formation of salts; thus, for instance, sulphuric acid, a compound of sulphur and oxygen, forms with the base potassa a salt, the sulphate of potassa. Two salts frequently combine with each other, forming what chemists call double-salts; thus, for instance, the sulphate of alumina and the sulphate of potassa form a double-salt, known as the double sulphate of alumina and potassa.

138. The chemical union of bodies is governed and regulated by certain fundamental laws, called the laws of combination, and which may be briefly stated as follows :

(1) All chemical compounds are definite in their nature, the ratio of the elements being constant ; in other terms, the same chemical compound invariably contains the same elements, combined in unvarying proportions.

(2) Where a body is capable of combining with another in several proportions, these proportions bear a simple relation to each other. Thus one equivalent of A will combine with 1, 2, 3, 4, 5, equivalents of B ; or two of A with 1, 2, 3, 4, 5, 6, 7, of B ; or three of A with 5, 7, of B ; and so on. This law, which was first advanced by Dalton, in 1807, is called the law of multiple proportions. The most simple proportions occur most frequently : we generally find between the component elements of compound bodies, the proportions of 1 to 1, of 1 to 2, of 1 to 3, of 1 to 4, of 1 to 5 ; or of 2 to 3, of 2 to 5, of 2 to 7.

3. The quantities in which two bodies unite with a third body, express also the relative proportions in which they unite with each other, pre-

suming always, of course, that they do unite with each other. For instance, hydrogen combines with oxygen in the proportion of 1 part (by weight) of the former to 8 parts (by weight) of the latter; chlorine combines with oxygen in the proportion of 35.5 parts (by weight) of the former to 8 parts (by weight) of the latter: chlorine combines accordingly with hydrogen in the proportion of 35.5 (by weight) of the former to 1 part (by weight) of the latter. As oxygen has a most extensive range of affinity, and very great powers of combination, uniting in fact with all the elementary substances, with the single exception of fluorine, and as its compounds are susceptible of the most rigid and exact analysis, this body has been chosen by chemists as the starting substance in the construction of the table of chemical equivalents. The number assigned to the equivalent of the starting substance is entirely arbitrary. Continental chemists usually assign the number 100 to the equivalent of oxygen, 12.5 to that of hydrogen, 443.75 to that of chlorine; but it will be readily seen that the relative ratio remains the same: 100 is to 12.5 as 8 is to 1, to 443.75 as 8 is to 35.5. 8 has been chosen here as the more convenient figure of the two, and because it is the proportion in which oxy-

gen combines with one part (by weight) of hydrogen to form water, supplying us thus, in the equivalent of the hydrogen, with a unity of which the equivalents of all other simple substances should be integer multiples, according to a theory advanced by a most eminent English chemist (Prout). A glance at the table of equivalents of elementary bodies will, however, suffice to show that, in the present state of our knowledge, at all events, this hypothesis is not sufficiently supported to justify its admission.

(4) The combining quantity or proportion of a compound is the sum of the combining quantities of its components. Let us take, for instance, chloride of sodium. The equivalent of chlorine is 35.5, that of sodium 23; the combining proportion or equivalent of the chloride of sodium is therefore 58.5.

139. Most of the compounds which the metalloids form with the metals, are now generally designated in chemical nomenclature as *ides*; but many of them were formerly, and are still by some chemists, designated as *urets*. The termination *ide* (or *uret*) is substituted for the termination of the name of the metalloid, and the preposition *of* interposed between this and the unaltered name of

the metal. Thus, for instance, the compound formed by the union of the metalloid chlorine with the metal sodium, is called chloride of sodium; the compound formed by oxygen with silver, is called oxide of silver, &c., &c.

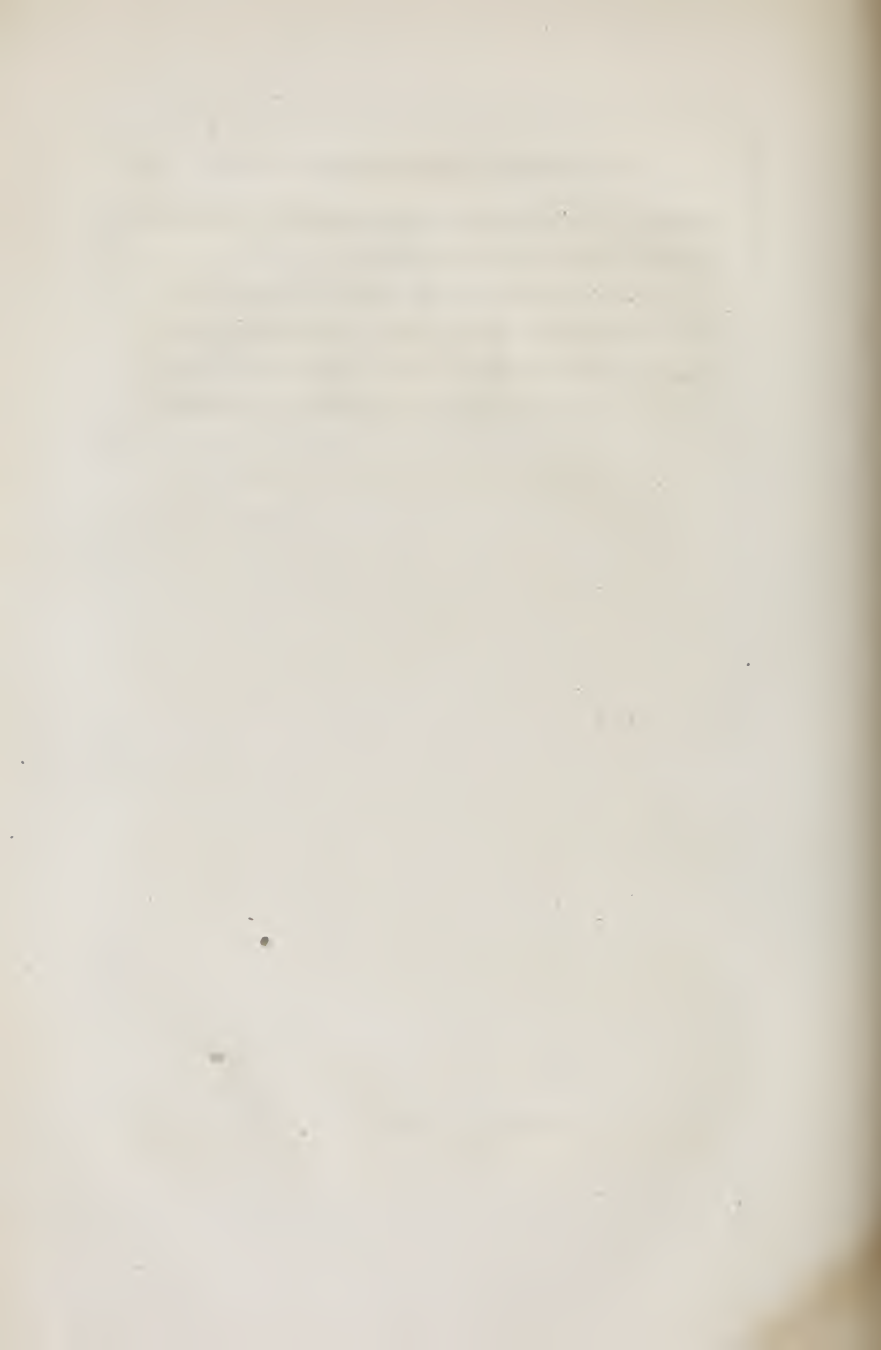
As has already been stated, bodies may combine with each other in several proportions, bearing a definite simple relation to each other.

Thus oxygen combines with manganese in six different proportions, viz., 1 to 1, 3 to 2, 2 to 1, 4 to 3, 3 to 1, and 7 to 2. The first compound (1 of oxygen to 1 of manganese) is called the protoxide of manganese; the second (3 of O to 2 of Mn), the sesquioxide; the third (2 of O to 1 of Mn), the deutoxide or binoxide; the fourth being, in reality, a compound of the protoxide with the sesquioxide, is properly called proto-sesquioxide; the fifth compound of oxygen with manganese ( $\text{Mn O}^3$ ), having acid properties, *i. e.*, combining with bases to form salts, is termed manganic acid. The composition of this acid would be indicated by the term teroxide of manganese. The term oxide, however, is not applied to bodies having acid properties; thus we do not say, for instance, teroxide of arsenic, or pentoxide of arsenic, but arsenious acid for the former, and arsenic acid for the

latter ; and the sixth compound ( $\text{Mn}^2 \text{O}_7$ ) is called hypermanganic or permanganic acid. Compounds containing less than one equivalent of oxygen to one equivalent of metal, are called suboxides ; thus  $\text{Cu}^2 \text{O}$  (two equivalents of copper to one of oxygen) is called suboxide of copper. The same rules hold generally good also in the nomenclature of compounds of oxygen with the metalloids, and in those of sulphur and other metalloids with the metals and with each other. Most of the metalloids form acids with oxygen, as chlorine, iodine, bromine, sulphur, phosphorus, nitrogen, carbon, selenium, boron, silicon, arsenic, tellurium ; some form acids with hydrogen, as chlorine, iodine, bromine, fluorine, sulphur : these latter acids are called respectively hydrochloric, hydriodic, hydrobromic, hydrofluoric, hydrosulphuric acids. With regard to the neutral or basic compounds, which the metalloids form among themselves, the termination *ide* is always given to the oxygen, wherever that body forms one of the constituents. Chlorine follows next after oxygen in this respect ; thus we say, chloride of iodine, of sulphur, of nitrogen. Bromine follows next after chlorine (bromide of iodine). The next is fluorine (fluoride of

silicon). After this comes sulphur (sulphide of arsenic, sulphide of carbon).

The compounds which phosphorus, carbon, arsenic, selenium, form with hydrogen, are called respectively, phosphuretted, carburetted, arseniuretted (or arseniетted), seleniuretted hydrogen.



## APPENDIX.

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### WEIGHTS AND MEASURES.

THERE are three standards of weights recognized in the United States and Great Britain, viz., the Avoirdupois, the Troy, and the Apothecaries'.

It would be a most desirable result if scientific societies would select from the various standards one complete standard of weights, and one of fluid measures, and sanction them by their political influence to the exclusion of all others. Modern international commercial intercourse demands this important innovation.

The cosmopolite, the scientific man, the man of commerce, and the people, would all alike be relieved from much embarrassment, mistakes, and of the necessity of re-learning a long catalogue of school-day lessons of the utmost importance.

#### AVOIRDUPOIS WEIGHT.

This is the one usually employed in buying and selling such articles as are measured by weight, and is also em-

ployed by apothecaries, but not in the dispensing of medicine.

|          |   |         |   |        |   |         |   |        |   |       | Troy Grains. |
|----------|---|---------|---|--------|---|---------|---|--------|---|-------|--------------|
| 1 dr.    | - | -       | - | -      | - | -       | - | -      | - | =     | 27·34375     |
| 16 "     | = | 1 oz.   | - | -      | - | -       | - | -      | - | =     | 437·5        |
| 256 "    | = | 16 "    | = | 1 lb.  | - | -       | - | -      | - | =     | 7000·        |
| 3584 "   | = | 224 "   | = | 14 "   | = | 1 stone | - | -      | - | =     | 98000·       |
| 28672 "  | = | 1792 "  | = | 112 "  | = | 8 "     | = | 1 cwt. | - | =     | 784000·      |
| 473440 " | = | 35840 " | = | 2240 " | = | 160 "   | = | 20 "   | = | 1 ton | =15680000·   |

In this country, most bulky articles are weighed by the short ton, 2000 pounds.

### TROY WEIGHT.

This is used in the exchange of gold, silver, platina, and precious stones.

|           |   |                         |
|-----------|---|-------------------------|
| 24 grains | = | 1 pennyweight.          |
| 480 "     | = | 20 " = 1 ounce.         |
| 5760 "    | = | 240 " = 12 " = 1 pound. |

### *Relative proportions between the Troy and Avoirdupois Weights.*

1 pound Troy is equal to 0·822857 pound avoirdupois, or 13 ounces, 2 drachms, 1 scruple, 8·7 grains, or 13 ounces, 148·7 grains.

1 ounce troy is equivalent to 1 ounce, 1 drachm, 1 scruple, and 6·225 grains avoirdupois.

1 pound avoirdupois is equal to 1·215277 pound troy, or 1 pound, 2 ounces, 4 drachms, and 2 scruples.

1 ounce avoirdupois is equal to 7 drachms 17·5 grains.

144 pounds avoirdupois are equivalent to 175 pounds troy.

175 ounces troy are equivalent to 192 ounces avoirdupois.

### APOTHECARIES' WEIGHT.

Used in compounding and dispensing of medicines.

|           |   |                                |
|-----------|---|--------------------------------|
| 20 grains | = | 1 scruple.                     |
| 60 "      | = | 3 " = 1 drachm.                |
| 480 "     | = | 24 " = 8 " = 1 ounce.          |
| 5760 "    | = | 288 " = 96 " = 12 " = 1 pound. |

Marks—gr. ℥, ℥, ℥, lb.

### DUBLIN WEIGHTS, (Adopted 1850.)

|              |   |                                 |
|--------------|---|---------------------------------|
| 18·22 grains | = | 1 scruple.                      |
| 54·68 "      | = | 3 " = 1 drachm.                 |
| 437·5 "      | = | 24 " = 8 " = 1 ounce.           |
| 7000 "       | = | 384 " = 128 " = 16 " = 1 pound. |

### FRENCH METRICAL WEIGHTS.

|               |               |              |          |              |               |              |   |   |   | Troy Grains. |
|---------------|---------------|--------------|----------|--------------|---------------|--------------|---|---|---|--------------|
| 1 milligramme | -             | -            | -        | -            | -             | -            | - | - | = | ·015434      |
| 10 =          | 1 centigramme | -            | -        | -            | -             | -            | - | - | = | ·15434       |
| 100 =         | 10 =          | 1 decigramme | -        | -            | -             | -            | - | - | = | 1·5434       |
| 1000 =        | 100 =         | 10 =         | 1 gramme | -            | -             | -            | - | - | = | 15·434       |
| 10000 =       | 1000 =        | 100 =        | 10 =     | 1 decagramme | -             | -            | - | - | = | 154·34       |
| 100000 =      | 10000 =       | 1000 =       | 100 =    | 10 =         | 1 hectogramme | -            | - | - | = | 1543·4       |
| 1000000 =     | 100000 =      | 10000 =      | 1000 =   | 100 =        | 10 =          | 1 kilogramme | - | - | = | 15434.       |

The above weights not being generally used by the French people, the following was substituted, in 1812, in

part; but in 1837 a law was passed which definitively abolished the use of all other weights and measures, excepting those of the metrical or decimal system, from and after August, 1840. The metrical weight, therefore, is now the only one permitted to be used throughout France.

#### VALUE OF TROY IN METRICAL WEIGHT.

|           |   |   |   |   |   |            |          |
|-----------|---|---|---|---|---|------------|----------|
| 1 pound   | - | - | - | - | = | 373.202    | grammes. |
| 1 ounce   | - | - | - | - | = | 31.10017   | "        |
| 1 drachm  | - | - | - | - | = | 3.887521   | "        |
| 1 scruple | - | - | - | - | = | 1.295840   | "        |
| 1 grain   | - | - | - | - | = | 0.06479201 | "        |

#### VALUE OF TROY IN MARC WEIGHT.

|           |   |   |   |   |   |                                  |
|-----------|---|---|---|---|---|----------------------------------|
| 1 pound   | - | - | - | - | = | 12 ounces, 1 gros, 42.32 grains. |
| 1 ounce   | - | - | - | - | = | 1 " 0 " 9.53 "                   |
| 1 drachm  | - | - | - | - | = | 0 " 1 " 1.19 "                   |
| 1 scruple | - | - | - | - | = | 0 " 0 " 24.40 "                  |
| 1 grain   | - | - | - | - | = | 0 " 0 " 1.22 "                   |

In all the European States, except in France,\* Dublin, and Turkey, the medicinal pound is divided into 12 ounces.

In all of them the ounce is divided into 8 drachms, except in Naples, where it contains 10. In all, the ounce is divided into 3 scruples; but the value of the scruple dif-

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\* In France, the standard of weights and measures is the same for all commercial products, chemicals, medicines, precious metals, etc., etc. The French government prohibits, by penal enactment, the use of old weights and measures.

fers. It is composed of 24 grains at Bologna, Coni, Lucca, Modena, Parma, and Rome, and in Spain, Portugal, Tuscany, and Sardinia. Of 20 grains in Great Britain (except in Dublin, where it is 18·22 grains), the United States, Austria, Bavaria, Holland, Poland, and Sweden; at Lubeck, Naples, Nuremberg, and Venice. Therefore the pound consists of 5760 grains in the United States, Great Britain, Austria, Bavaria, Holland, Poland, Prussia, and Sweden; at Lubeck, Naples, and Venice. In Turkey 6400 grains. 6912 grains in Spain, Portugal, Tuscany, Sardinia, Bologna, Lucca, Modena, Parma, Rome, and Coni. 7000 grains in Dublin; 7200 grains at Naples.

## WINE OR APOTHECARIES' MEASURE.

*(Adopted by the United States Dispensatory.)*

|         |                   |   |   |   |                    | Cubic Inches. | Grains Troy.     |
|---------|-------------------|---|---|---|--------------------|---------------|------------------|
| 1 minim | -                 | - | - | - | -                  |               | 0·95             |
| 60 =    | 1 fluidrachm      | - | - | - | -                  | =             | 0·2256 = 56·96   |
| 480 =   | 8 = 1 fluidounce  | - | - | - | -                  | =             | 1·8047 = 455·69  |
| 7680 =  | 128 = 16 = 1 pint | - | - | - | -                  | =             | 28·375 = 7291·11 |
| 61440 = | 1024 = 128 = 8    |   |   |   | = 1 gallon (Cong.) | =             | 231· = 58328·83  |

## IMPERIAL MEASURE.

*(Adopted by all the British Colleges.)*

| Minims. |             |   |              |   |          | Grains Troy. | Avoir.                        |
|---------|-------------|---|--------------|---|----------|--------------|-------------------------------|
| 1       | -           | - | -            | - | -        | =            | 0·91                          |
| 60 =    | 1 f. drachm | - | -            | - | -        | =            | 54·7                          |
| 480 =   | 8           | " | = 1 f. ounce | - | -        | =            | 437·5 = 1 ounce.              |
| 9600 =  | 160         | " | = 20         | " | = 1 pint | =            | 8750· = 1·25 lb.              |
| 76800 = | 1280        | " | = 160        | " | = 8      | "            | = 1 gallon = 70000· = 10 lbs. |

### VALUE OF WINE OR APOTHECARIES' MEASURE IN IMPERIAL MEASURE.

| Wine Measure.      | Imperial Measure. |              |              |         |
|--------------------|-------------------|--------------|--------------|---------|
|                    | Pints.            | Fluidounces. | Fluidrachms. | Minims. |
| 1 gallon - - - -   | = 6               | 13           | 2            | 23      |
| 1 pint - - - -     | = 0               | 16           | 5            | 18      |
| 1 fluidounce - - - | = 0               | 1            | 0            | 20      |
| 1 fluidrachm - - - | = 0               | 0            | 1            | 25      |
| 1 minim - - - -    | = 0               | 0            | 0            | 104     |

### VALUE OF IMPERIAL IN WINE OR APOTHECARIES' MEASURE.

|                    | Gallon. | Pints. | Fluidounces. | Fluidrachms. | Minims. |
|--------------------|---------|--------|--------------|--------------|---------|
| 1 gallon - - - -   | = 1     | 1      | 9            | 5            | 8       |
| 1 pint - - - -     | = 0     | 1      | 3            | 1            | 38      |
| 1 fluidounce - - - | = 0     | 0      | 0            | 7            | 41      |
| 1 fluidrachm - - - | = 0     | 0      | 0            | 0            | 58      |
| 1 minim - - - -    | = 0     | 0      | 0            | 0            | 09      |

### FRENCH MEASURE OF CAPACITY—APOTHECARIES' MEASURE.

|                                                     |                  |
|-----------------------------------------------------|------------------|
| 1 millilitre - - - -                                | = 162318 minims. |
| 10= 1 centilitre - - -                              | = 27053 fl. dr.  |
| 100= 10= 1 decilitre - - -                          | = 38516 fl. oz.  |
| 1000= 100= 10= 1 litre - - -                        | = 21135 pints.   |
| 10000= 1000= 100= 10= 1 decalitre - - -             | = 26419 gallons. |
| 100000= 10000= 1000= 100= 10= 1 hectolitre - - -    | = 264190 "       |
| 1000000=100000=10000=1000=100=10= 1 kilolitre - - - | = 2641900 "      |

## THERMOMETERS.

THE Fahrenheit scale is divided into 180 equal degrees between the points at which ice melts and water boils; then counting downward 32 degrees from the point of melting ice to obtain zero.

The Centigrade thermometer fixes its zero at the point of melting ice, and the boiling point of water at  $100^{\circ}$ , the scale being equally divided between the two points.

*To reduce Centigrade degrees to those of Fahrenheit.*

RULE.—Multiply by 9, divide the product by 5, and add 32.

$$\text{Thus, } \overset{\text{Cent.}}{40} \times 9 \div 5 + 32 = \overset{\text{Fahr.}}{104}.$$

*To reduce Fahrenheit's degrees to those of Centigrade.*

RULE.—Subtract 32, multiply by 5, and divide by 9.

$$\text{Thus, } \overset{\text{Fahr.}}{104} - 32 \times 5 \div 9 = \overset{\text{Cent.}}{40}.$$

*To reduce Reaumur's degrees to those of Fahrenheit.*

RULE.—Multiply by 9, divide by 4, and add 32.

$$\text{Thus, } \overset{\text{Reaumur.}}{32} \times 9 \div 4 + 32 = \overset{\text{Fahr.}}{104}.$$

*To reduce Fahrenheit's degrees to those of Reaumur.*

RULE.—Subtract 32, multiply by 4, and divide by 9.

$$\text{Thus, } \overset{\text{Fahr.}}{104} - 32 \times 4 \div 9 = \overset{\text{Reaum.}}{32}.$$

*To reduce Reaumur's degrees to those of Centigrade.*

RULE.—Multiply by 5, and divide by 4.

$$\text{Thus, } \overset{\text{Reaum.}}{32} \times 5 \div 4 = \overset{\text{Cent.}}{40}.$$

*To reduce Centigrade degrees to those of Reaumur.*

RULE.—Multiply by 4, and divide by 5.

$$\text{Thus, } \overset{\text{Cent.}}{40} \times 4 \div 5 = \overset{\text{Reaum.}}{32}.$$

TABLE OF THE MOST IMPORTANT CHEMICAL ELEMENTS, OR  
SIMPLE BODIES, WITH THEIR RESPECTIVE SYMBOLS AND  
COMBINING PROPORTIONS.

| NAME.                 | SYMBOL. | EQUIVALENTS, OR<br>COMBINING PROPORTIONS. |             |
|-----------------------|---------|-------------------------------------------|-------------|
|                       |         | OXYGEN=100.                               | HYDROGEN=1. |
| Aluminium - - -       | Al.     | 170.5                                     | 13.6        |
| Antimony (Stibium) -  | Sb.     | 1612.5                                    | 129.0       |
| Arsenic - - - -       | As.     | 937.5                                     | 75.0        |
| Barium - - - -        | Ba.     | 857.5                                     | 68.6        |
| Bismuth - - - -       | Bi.     | 2600.0                                    | 208.0       |
| Boron - - - -         | B.      | 136.2                                     | 10.9        |
| Bromine - - - -       | Br.     | 1000.0                                    | 80.0        |
| Calcium - - - -       | Ca.     | 250.0                                     | 20.0        |
| Carbon - - - -        | C.      | 75.0                                      | 6.0         |
| Chlorine - - - -      | Cl.     | 443.7                                     | 35.5        |
| Chromium - - - -      | Cr.     | 335.0                                     | 26.8        |
| Cobalt - - - -        | Co.     | 368.6                                     | 29.5        |
| Copper (Cuprum) -     | Cu.     | 396.0                                     | 31.7        |
| Fluorine - - - -      | F.      | 237.5                                     | 19.0        |
| Gold (Aurum) - - -    | Au.     | 2462.5                                    | 197.0       |
| Hydrogen - - - -      | H.      | 12.5                                      | 1.0         |
| Iodine - - - -        | I.      | 1585.0                                    | 126.8       |
| Iron (Ferrum) - - -   | Fe.     | 350.0                                     | 28.0        |
| Lead (Plumbum) - -    | Pb.     | 1294.6                                    | 103.6       |
| Magnesium - - - -     | Mg.     | 150.2                                     | 12.1        |
| Manganese - - - -     | Mn.     | 344.7                                     | 27.6        |
| Mercury (Hydrargyrum) | Hg.     | 1250.0                                    | 100.0       |
| Molybdenum - - - -    | Mo.     | 575.0                                     | 46.0        |
| Nickel - - - -        | Ni.     | 369.3                                     | 29.6        |
| Nitrogen - - - -      | N.      | 175.0                                     | 14.0        |
| Oxygen - - - -        | O.      | 100.0                                     | 8.0         |
| Phosphorus - - - -    | Ph.     | 392.0                                     | 31.4        |
| Platinum - - - -      | Pt.     | 1236.7                                    | 98.9        |
| Potassium (Kalium) -  | K.      | 490.0                                     | 39.2        |
| Selenium - - - -      | Se.     | 494.0                                     | 39.5        |
| Silver (Argentum) - - | Ag.     | 1849.6                                    | 108.0       |
| Sodium (Natrium) - -  | Na.     | 287.5                                     | 23.0        |
| Strontium - - - -     | Sr.     | 545.9                                     | 43.7        |
| Sulphur - - - -       | S.      | 200.0                                     | 16.0        |
| Tin (Stannum) - - -   | Sn.     | 735.8                                     | 58.8        |
| Uranium - - - -       | U.      | 742.9                                     | 59.5        |
| Zinc - - - -          | Zn.     | 406.6                                     | 32.5        |

TABLE OF THE MOST IMPORTANT CHEMICAL COMPOUNDS'  
(IN A PHOTOGRAPHIC POINT OF VIEW), WITH THEIR  
FORMULÆ AND COMBINING PROPORTIONS.

| NAME.                                           | FORMULA.                                                                                     | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|-------------------------------------------------|----------------------------------------------------------------------------------------------|----------------------------------------------------------|
| Acetate of Alumina - -                          | $\text{Al}_2\text{O}_3, \bar{\text{A}}$                                                      | 204.2                                                    |
| “ “ baryta - -                                  | $\text{BaO}, \bar{\text{A}} + \text{HO}$                                                     | 136.6                                                    |
| “ “ copper, neutral<br>crystallized - -         | $\text{CuO}, \bar{\text{A}} + \text{HQ}$                                                     | 99.7                                                     |
| Acetate of lead, neutral<br>(sugar of lead) - - | $\text{PbO}, \bar{\text{A}} + 3\text{HO}$                                                    | 189.6                                                    |
| Acetate of soda - -                             | $\text{NaO}, \bar{\text{A}} + 6\text{HO}$                                                    | 136.0                                                    |
| Acetic acid - - -                               | $\text{C}_4\text{H}_2\text{O}_3 + \text{HO} = \bar{\text{A}}$<br>$+ \text{HO}$               | 60.0                                                     |
| Alcohol - - -                                   | $\text{C}_4\text{H}_5\text{O}_2 + \text{HO}$                                                 | 55.0                                                     |
| Alum, Ammonia- -                                | $\text{NH}_4\text{O}, \text{SO}_3 + \text{Al}_2$<br>$\text{O}_3, 3\text{SO}_3 + 24\text{HO}$ | 453.2                                                    |
| “ potassa- - -                                  | $\text{KO}, \text{SO}_3 + \text{Al}_2\text{O}_3,$<br>$3\text{SO}_3 + 24\text{HO}$            | 474.4                                                    |
| Ammoniacal gas (spirits of<br>hartshorn) - -    | $\text{NH}_3$                                                                                | 17.0                                                     |
| Ammonia, solution or li-<br>quor of - - -       | $\text{NH}_3 + x\text{HO}$                                                                   |                                                          |
| Amylum ( <i>see</i> Starch) - -                 |                                                                                              |                                                          |
| Antimoniate of potassa - -                      | $\text{KO}, \text{SbO}_3$                                                                    | 216.2                                                    |
| Arseniate of potassa - -                        | $\text{KO}, \text{AsO}_3 + 2\text{HO}$                                                       | 180.2                                                    |
| Baryta - - -                                    | $\text{BaO}$                                                                                 | 76.6                                                     |
| Benzoic acid - - -                              | $\text{C}_{14}\text{H}_5\text{O}_3 + \text{HO}$                                              | 122.0                                                    |
| Biborate of soda (borax) - -                    | $\text{NaO}, 2\text{BO}_3 + 10\text{HO}$                                                     | 190.8                                                    |
| Boracic acid, crystallized - -                  | $\text{BO}_3 + 3\text{HO}$                                                                   | 61.9                                                     |
| Bromic acid - - -                               | $\text{BrO}_3$                                                                               | 120.0                                                    |
| Bromide of potassium - -                        | $\text{KBr}$                                                                                 | 119.2                                                    |
| “ “ silver - -                                  | $\text{AgBr}$                                                                                | 188.0                                                    |
| “ “ sodium - -                                  | $\text{NaBr}$                                                                                | 103.0                                                    |
| Bromiodine - - -                                | $\text{IBr}_3$                                                                               | 366.8                                                    |
| Camphor, Japan - - -                            | $\text{C}_{10}\text{H}_8\text{O}$                                                            | 76.0                                                     |
| Carbonate of ammonia - -                        | $\text{NH}_3, \text{CO}_2$                                                                   | 39.0                                                     |
| “ “ ses-<br>quicarbonate - -                    | $2\text{NH}_4, \text{O} + 3\text{CO}_2$                                                      | 118.0                                                    |
| Carbonate of baryta - -                         | $\text{BaO}, \text{CO}_2$                                                                    | 98.6                                                     |
| “ “ lime - -                                    | $\text{CaO}, \text{CO}_2$                                                                    | 50.0                                                     |
| “ “ magnesia - -                                | $\text{MgO}, \text{CO}_2 + 3\text{HO}$                                                       | 69.1                                                     |
| “ “ potassa (neu-<br>tral) - - -                | $\text{KO}, \text{CO}_2$                                                                     | 69.2                                                     |

| NAME.                                           | FORMULA.                                   | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|-------------------------------------------------|--------------------------------------------|----------------------------------------------------------|
| Carbonate of potassa (acid<br>or bicarbonate) - | $\text{KO}, 2\text{CO}_2 + \text{HO}$      | 100.2                                                    |
| Carbonate of soda (crystall.)                   | $\text{NaO}, \text{CO}_2 + 10\text{HO}$    | 143.0                                                    |
| “ “ soda (bicarbonate) -                        | $\text{NaO}, 2\text{CO}_2 + \text{HO}$     | 84.0                                                     |
| Carbonate of strontia -                         | $\text{SrO}, \text{CO}_2$                  | 73.7                                                     |
| Carbonic acid -                                 | $\text{CO}_2$                              | 22.0                                                     |
| Caoutchouc -                                    | $\text{C}_8\text{H}_7$                     | 55.0                                                     |
| Chlorate of ammonia -                           | $\text{NH}_4\text{O}, \text{ClO}_3$        | 101.5                                                    |
| “ “ baryta -                                    | $\text{BaO}, \text{ClO}_3 + \text{HO}$     | 161.1                                                    |
| “ “ potassa -                                   | $\text{KO}, \text{ClO}_3$                  | 122.7                                                    |
| “ “ soda -                                      | $\text{NaO}, \text{ClO}_3$                 | 106.5                                                    |
| Chloric acid -                                  | $\text{ClO}_3$                             | 75.5                                                     |
| Chloride of aluminium<br>(sesquichl.) -         | $\text{Al}_2\text{Cl}_3 + 12\text{HO}$     | 241.7                                                    |
| Chloride of ammonium<br>(sal-ammoniac) -        | $\text{NH}_4, \text{Cl}$                   | 53.5                                                     |
| Chloride of arsenic -                           | $\text{AsCl}_3$                            | 181.5                                                    |
| “ “ barium -                                    | $\text{BaCl} + 2\text{HO}$                 | 122.1                                                    |
| “ “ cobalt -                                    | $\text{CoCl}$                              | 65.0                                                     |
| “ “ copper (subchloride) -                      | $\text{Cu}_2\text{Cl}$                     | 98.9                                                     |
| Chloride of copper, crystallized -              | $\text{CuCl} + 4\text{HO}$                 | 103.2                                                    |
| Chloride of cyanogen, gaseous (proto-) -        | $\text{CyCl}$                              | 61.5                                                     |
| Chloride of cyanogen, solid (sesqui.) -         | $\text{Cy}_2\text{Cl}_3$                   | 158.5                                                    |
| Chloride of gold (terchlor.)                    | $\text{AuCl}_3 + 6\text{HO}$               | 357.5                                                    |
| “ “ gold and sodium                             | $\text{NaCl} + \text{AuCl}_3 + 6\text{HO}$ | 416.0                                                    |
| “ “ iodine, liquid (proto-) -                   | $\text{ICl}$                               | 162.3                                                    |
| Chloride of iodine, solid (ter) -               | $\text{ICl}_3$                             | 233.3                                                    |
| Chloride of iron, proto- -                      | $\text{FeCl} + 4\text{HO}$                 | 99.5                                                     |
| “ “ sesqui- -                                   | $\text{Fe}_2\text{Cl}_3 + 6\text{HO}$      | 216.5                                                    |
| Chloride of lead, neutral -                     | $\text{PbCl}$                              | 139.1                                                    |
| “ “ lime (bleaching powder) -                   | $\text{CaO}, \text{ClO} + \text{CaCl}$     | 127.0                                                    |
| Chloride of magnesium, crystal. -               | $\text{MgCl} + 5\text{HO}$                 | 92.6                                                     |
| Chloride of manganese, proto- -                 | $\text{MnCl} + 4\text{HO}$                 | 99.1                                                     |
| Chloride of manganese, sesqui- -                | $\text{Mn}_2\text{Cl}_3$                   | 161.7                                                    |

| NAME.                                                                               | FORMULA.                                                                      | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|----------------------------------------------------------|
| Chloride of mercury (cor-<br>rosive sublimate) - }                                  | HgCl                                                                          | 135.5                                                    |
| Chloride of nickel - - }                                                            | NiCl + 10HO                                                                   | 155.1                                                    |
| “ “ and am-<br>monia (ammonio-chlo-<br>ride of nickel) - - }                        | NiCl + 2NH <sub>3</sub> + HO                                                  | 108.1                                                    |
| Chloride of nitrogen (terchl.)                                                      | NCl <sub>3</sub>                                                              | 120.5                                                    |
| “ “ platinum, hy-<br>drated bichloride - }                                          | PtCl <sub>2</sub> + 8HO                                                       | 241.9                                                    |
| Chloride of potassium - - }                                                         | KCl                                                                           | 74.7                                                     |
| “ “ silver - - - }                                                                  | AgCl                                                                          | 143.5                                                    |
| “ “ sodium (com-<br>mon salt) - - - }                                               | NaCl                                                                          | 58.5                                                     |
| Chloride of strontium - - }                                                         | SrCl + 6HO                                                                    | 133.2                                                    |
| “ “ sulphur(subchl.)                                                                | S <sub>2</sub> Cl                                                             | 67.5                                                     |
| “ “ tin, crystalliz-<br>ed proto- - - - }                                           | SnCl + HO                                                                     | 103.3                                                    |
| Chloride of tin, crystal-<br>lized bichloride - - }                                 | SnCl <sub>2</sub> + 2HO                                                       | 147.8                                                    |
| Chloroform - - - - }                                                                | C <sub>2</sub> HCl <sub>3</sub>                                               | 119.5                                                    |
| Chromate of lead, neutral -                                                         | PbO, CrO <sub>3</sub>                                                         | 162.2                                                    |
| “ “ potassa, neutral                                                                | KO, CrO <sub>3</sub>                                                          | 98.0                                                     |
| “ “ “ acid }                                                                        | KO, 2CrO <sub>3</sub>                                                         | 148.8                                                    |
| or bichromate - - - }                                                               |                                                                               |                                                          |
| Citrate of sesquioxide of iron                                                      |                                                                               |                                                          |
| “ “ sesquioxide of<br>iron and ammonia - }                                          |                                                                               |                                                          |
| Citrate of sesquioxide of<br>iron and potassa - }                                   |                                                                               |                                                          |
| Citrate of sesquioxide of<br>iron and soda - - }                                    |                                                                               |                                                          |
| Citrate of mercury - - - }                                                          |                                                                               |                                                          |
| “ “ silver - - - - }                                                                |                                                                               |                                                          |
| Citric acid, by crystalliza-<br>tion at the common tem-<br>perature - - - - }       | C <sub>12</sub> H <sub>5</sub> O <sub>11</sub> + 5HO = $\overline{\text{Ci}}$ | 210.0                                                    |
| Citric acid, precipitated<br>from a hot saturated so-<br>lution, and dried at 212°. | C <sub>12</sub> H <sub>5</sub> O <sub>11</sub> + 3HO = $\overline{\text{Ci}}$ | 192.0                                                    |
| Cobalt, oxide of - - - }                                                            | CoO                                                                           | 37.5                                                     |
| Cotton - - - - - }                                                                  | CHO                                                                           | 15.0                                                     |
| Cyanate of potassa - - - }                                                          | KO, CyO                                                                       | 81.2                                                     |
| Cyanic acid - - - - - }                                                             | CyO + HO                                                                      | 43.0                                                     |
| Cyanide of potassium - - }                                                          | KCy                                                                           | 65.2                                                     |
| “ “ silver - - - - }                                                                | AgCy                                                                          | 134.0                                                    |

| NAME.                                                         | FORMULA.                           | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|---------------------------------------------------------------|------------------------------------|----------------------------------------------------------|
| Cyanogen - - - -                                              | $C_2 N = Cy$                       | 26.0                                                     |
| Ether - - - -                                                 | $C_4 H_5 O$                        | 37.0                                                     |
| Ferrieyanide of potassium }<br>(red prussiate of potassa )    | $3KCy, Fe_2 Cy_3$                  | 329.6                                                    |
| Ferrocyanide of potassium }<br>(yellow prussiate of potassa ) | $2KCy, FeCy + 3HO$                 | 211.4                                                    |
| Fluoride of ammonium -                                        | $NH_4, Fl$                         | 37.0                                                     |
| " " calcium (fluor-spar) - - - }                              | $CaFl$                             | 39.0                                                     |
| Fluoride of potassium -                                       | $KFl$                              | 58.2                                                     |
| " " sodium - - -                                              | $NaFl$                             | 42.0                                                     |
| Formic acid - - - -                                           | $C_2 HO_3 + HO = \overline{Fo}$    | 46.0                                                     |
| Gallic acid, crystallized -                                   | $C_7 H_2 O_4 + HO = \overline{Ga}$ | 85.0                                                     |
| Gold, oxide (teroxide) of -                                   | $AuO_3$                            | 221.0                                                    |
| Hydrobromic acid - -                                          | $BrH$                              | 81.0                                                     |
| Hydrochloric acid - -                                         | $ClH$                              | 36.5                                                     |
| Hydrochloric acid, most concentrated hydrated }               | $ClH + 6HO$                        | 90.5                                                     |
| Hydrocyanic acid - -                                          | $CyH$                              | 27.0                                                     |
| Hydrofluat of ammonia -                                       |                                    |                                                          |
| Hydrofluoric acid - -                                         | $FH$                               | 20.0                                                     |
| Hydriodate of ammonia -                                       | $NH_3, HI$                         | 144.8                                                    |
| Hydriodic acid - - -                                          | $HI$                               | 127.8                                                    |
| Hydrosulphuric acid (sulphuretted hydrogen) }                 | $HS$                               | 17.0                                                     |
| Hyponitrate of protoxide of iron - - - - }                    |                                    |                                                          |
| Hyponitric acid - - -                                         | $NO_4$                             | 46.0                                                     |
| Hyposulphate of protoxide of iron - - - }                     |                                    |                                                          |
| Hyposulphate of soda - -                                      | $NaO, S_2 O_2 + 5HO$               | 124.0                                                    |
| Hyposulphuric acid - -                                        | $S_2 O_5$                          | 72.0                                                     |
| Hyposulphurous acid - -                                       | $S_2 O_2$                          | 48.0                                                     |
| Iodate of ammonia - -                                         | $NH_4 O, IO_5$                     | 192.8                                                    |
| Iodic acid - - - -                                            | $IO_5 + HO$                        | 175.8                                                    |
| Iodide of ammonium - -                                        | $NH_4, I$                          | 144.8                                                    |
| " " iron (sesqui-) - -                                        | $Fe_2 I_3$                         | 436.4                                                    |
| " " potassium - - -                                           | $KI$                               | 166.0                                                    |
| " " silver - - - -                                            | $AgI$                              | 234.8                                                    |
| " " sodium - - - -                                            | $NaI$                              | 149.8                                                    |
| Iron, protoxide of - - -                                      | $FeO$                              | 86.0                                                     |
| " sesquioxide of - - -                                        | $Fe_2 O_3$                         | 80.0                                                     |
| " hydrated sesquioxide of - - - }                             | $Fe_2 O_3 + 3HO$                   | 107.0                                                    |

| NAME.                                               | FORMULA.                                                                    | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|-----------------------------------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------|
| Lime, hydrate of - -                                | $\text{CaO} + \text{HO}$                                                    | 37.0                                                     |
| Malic acid - - - -                                  | $\text{C}_4 \text{H}_2 \text{O}_4 + \text{HO} = \overline{\text{M}}$        | 67.0                                                     |
| Manganate of potassa - -                            | $\text{KO}, \text{MnO}_3$                                                   | 93.8                                                     |
| “ “ “ per- - -                                      | $\text{KO}, \text{Mn}_2 \text{O}_7$                                         | 158.4                                                    |
| Milk sugar - - - -                                  | $\text{C}_{24} \text{H}_{22} \text{O}_{22} + 2\text{HO}$                    | 360.0                                                    |
| Nickel, oxide of - - -                              | $\text{NiO}$                                                                | 37.6                                                     |
| Nitrate of ammonia - -                              | $\text{NH}_4 \text{O}, \text{NO}_5 + \text{HO}$                             | 89.0                                                     |
| “ “ baryta - - -                                    | $\text{BaO}, \text{NO}_5$                                                   | 130.6                                                    |
| “ “ sesquioxide of }<br>chromium - - -              | $\text{Cr}_2 \text{O}_3, 3\text{NO}_5$                                      | 239.6                                                    |
| Nitrate of copper - -                               | $\text{CuO}, \text{NO}_5$                                                   | 93.7                                                     |
| “ “ sesquioxide of }<br>iron - - -                  | $\text{Fe}_2 \text{O}_3, 3\text{NO}_5$                                      | 242.0                                                    |
| Nitrate of lead - - -                               | $\text{PbO}, \text{NO}_5$                                                   | 165.6                                                    |
| “ “ mercury - - -                                   | $2(\text{HgO}, \text{NO}_5) + \text{HO}$                                    | 338.0                                                    |
| “ “ mercury and }<br>ammonia - - -                  | $(\text{NH}_3, \text{NO}_5) + 3\text{HgO}$                                  | 395.0                                                    |
| Nitrate of nickel - - -                             | $\text{NiO}, \text{NO}_5 + 6\text{HO}$                                      | 145.6                                                    |
| “ “ potassa - - -                                   | $\text{KO}, \text{NO}_5$                                                    | 101.2                                                    |
| “ “ silver - - -                                    | $\text{AgO}, \text{NO}_5$                                                   | 170.0                                                    |
| “ “ “ and am- }<br>monia - - -                      | $\text{AgO}, \text{NO}_5 + 2\text{NH}_3$                                    | 204.0                                                    |
| Nitrate of soda - - -                               | $\text{NaO}, \text{NO}_5$                                                   | 85.0                                                     |
| “ “ strontia - - -                                  | $\text{SrO}, \text{NO}_5$                                                   | 105.7                                                    |
| “ “ zinc - - -                                      | $\text{ZnO}, \text{NO}_5$                                                   | 94.5                                                     |
| Nitric acid, first hydrate -                        | $\text{NO}_5 + \text{HO}$                                                   | 63.0                                                     |
| Oxalate of ammonia, neu- }<br>tral - - -            | $\text{NH}_4 \text{O}, \text{C}_2 \text{O}_3 + \text{HO}$                   | 71.0                                                     |
| Oxalate of ammonia, acid }<br>(binoxalate) - - -    | $\text{NH}_4 \text{O}, 2\text{C}_2 \text{O}_3 + \}$<br>$2\text{HO}$         | 116.0                                                    |
| Oxalate of baryta - - -                             | $\text{BaO}, \text{C}_2 \text{O}_3 + \text{HO}$                             | 121.6                                                    |
| “ “ cobalt and am- }<br>monia - - -                 | $12\text{NH}_3 + \text{C}_6 \text{Co}_3 \}$<br>$\text{O}_{12} + 6\text{HO}$ | 478.5                                                    |
| Oxalate of copper and }<br>soda - - -               | $\text{C}_2 \text{NaCuO}_4 + 2\text{HO}$                                    | 116.7                                                    |
| Oxalate of sesquioxide of }<br>iron - - -           | $\text{Fe}_2 \text{O}_3, 3\text{C}_2 \text{O}_3$                            | 183.0                                                    |
| Oxalate of sesquioxide of }<br>iron and ammonia - - | $\text{C}_6 (8\text{NH}_4 \text{O}) \text{Fe}_2 \text{O}_{12}$              | 266.0                                                    |
| Oxalate of sesquioxide of }<br>iron and baryta - -  | $\text{C}_6 \text{Ba}_3 \text{Fe}_2 \text{O}_{12} + \}$<br>$21\text{HO}$    | 582.8                                                    |
| Oxalate of sesquioxide of }<br>iron and potassa - - | $\text{C}_6 \text{K}_3 \text{Fe}_2 \text{O}_{12}$                           | 305.6                                                    |
| Oxalate of sesquioxide of }<br>iron and soda - - -  | $\text{C}_6 \text{Na}_3 \text{Fe}_2 \text{O}_{12} + \}$<br>$10\text{HO}$    | 347.0                                                    |

| NAME.                                                           | FORMULA.                                                                                | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|-----------------------------------------------------------------|-----------------------------------------------------------------------------------------|----------------------------------------------------------|
| Oxalate of sesquioxide of<br>iron and strontia - - }            | $C_6 Sr_3 Fe_2 O_{12} + \left. \begin{matrix} 18HO \\ \end{matrix} \right\}$            | 481.1                                                    |
| Oxalate of lead - - - }                                         | $PbO, C_2 O_3$                                                                          | 147.6                                                    |
| “ “ nickel - - - }                                              | $NiO, C_2 O_3 + 2HO$                                                                    | 91.6                                                     |
| “ “ and am-<br>monia - - - }                                    |                                                                                         |                                                          |
| Oxalate of potassa, neutral -                                   | $KO, C_2 O_3 + HO$                                                                      | 92.2                                                     |
| “ “ “ acid, or<br>binoxalate (sorrel salt) }                    | $KO, 2C_2 O_3 + HO \left. \begin{matrix} + 2aq \\ \end{matrix} \right\}$                | 146.2                                                    |
| Oxalate of soda, neutral -                                      | $NaO, C_2 O_3$                                                                          | 67.0                                                     |
| Oxalic acid - - - }                                             | $C_2 O_3 + HO + 2aq \left. \begin{matrix} = \overline{Ox} \\ \end{matrix} \right\}$     | 63.0                                                     |
| Phosphate of potassa - -                                        | $KO, PO_5$                                                                              | 118.6                                                    |
| “ “ silver - - -                                                | $AgO, PO_5$                                                                             | 187.4                                                    |
| “ “ soda - - -                                                  | $NaO, PO_5$                                                                             | 102.4                                                    |
| Potassa - - -                                                   | $KO$                                                                                    | 47.2                                                     |
| “ hydrate of - - -                                              | $KO + HO$                                                                               | 56.2                                                     |
| Prussian blue - - - }                                           | $3FeCy + 2Fe_2 Cy_3 \left. \begin{matrix} + 9HO \\ \end{matrix} \right\}$               | 511.0                                                    |
| Pyrogallie acid - - -                                           | $C_6 H_3 O_3 = pG$                                                                      | 63.0                                                     |
| Racemic acid ( <i>see</i> Uvic acid)                            |                                                                                         |                                                          |
| Sal-ammoniac ( <i>see</i> Chloride<br>of ammonium) - - }        |                                                                                         |                                                          |
| Silver, oxide of - - -                                          | $AgO$                                                                                   | 116.0                                                    |
| Soda - - -                                                      | $NaO$                                                                                   | 31.0                                                     |
| “ hydrate of - - -                                              | $NaO + HO$                                                                              | 40.0                                                     |
| Stannate of potassa - - -                                       | $KO, SnO_2 + 3HO$                                                                       | 149.0                                                    |
| Starch - - -                                                    | $C_{12} H_{10} O_{10}$                                                                  | 162.0                                                    |
| Succinate of ammonia, acid -                                    |                                                                                         |                                                          |
| “ “ sesquioxide of<br>iron - - - }                              | $Fe_2 O_3, 3\overline{Su}$                                                              | 230.0                                                    |
| Succinate of potassa, acid -                                    |                                                                                         |                                                          |
| Succinic acid, crystallized }                                   | $C_4 H_2 O_3 + HO = \left. \begin{matrix} \overline{Su} + HO \\ \end{matrix} \right\}$  | 59.0                                                     |
| Succinic acid, sublimed }                                       | $2C_4 H_2 O_3 + HO = \left. \begin{matrix} \overline{Su} + HO \\ \end{matrix} \right\}$ | 109.0                                                    |
| Sugar - - -                                                     | $C_{12} H_{11} O_{11}$                                                                  | 171.0                                                    |
| “ of lead ( <i>see</i> Acetate<br>of lead) - - - }              |                                                                                         |                                                          |
| Sulphate of ammonia, crys-<br>tallized - - - }                  | $NH_3, SO_3$                                                                            | 57.0                                                     |
| Sulphate of sesquioxide<br>of chromium and am-<br>monia - - - } | $NH^4 O, SO_3 + Cr_2 \left. \begin{matrix} O_3, 3SO_3 + 24HO \\ \end{matrix} \right\}$  | 479.6                                                    |

| NAME.                                                                            | FORMULA.                                                    | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|----------------------------------------------------------------------------------|-------------------------------------------------------------|----------------------------------------------------------|
| Sulphate of sesquioxide<br>of chromium and po-<br>tassa - - - }                  | $KO, SO_3 + Cr_2 O_3, \}$<br>$3SO_3 + 24HO$                 | 500.8                                                    |
| Sulphate of cobalt and<br>ammonia - - - }                                        | $(NH_4 O, SO_3) + \}$<br>$(CoO, SO_3) + \}$<br>$6HO$        | 197.5                                                    |
| Sulphate of copper (blue<br>vitriol) - - - }                                     | $CuO, SO_3 + 5HO$                                           | 124.7                                                    |
| Sulphate of copper and<br>ammonia - - - }                                        | $NH_4 O, SO_3 + CuO, \}$<br>$SO_3$                          | 145.7                                                    |
| Sulphate of protoxide of<br>iron (green vitriol) - }                             | $FeO, SO_3 + 7HO$                                           | 139.0                                                    |
| Sulphate of sesquioxide of<br>iron and ammonia - }                               | $(NH_4 O, SO_3) + \}$<br>$(Fe_2 O_3, 3SO_3) \}$<br>$+ 24HO$ | 482.0                                                    |
| Sulphate of sesquioxide of<br>iron and potassa - }                               | $KO, SO_3 + Fe_2 O_3, \}$<br>$3SO_3 + 24HO$                 | 508.2                                                    |
| Sulphate of nickel - - }                                                         | $NiO, SO_3 + 7HO$                                           | 140.6                                                    |
| “ “ potassa, neu-<br>tral - - - }                                                | $KO, SO_3$                                                  | 87.2                                                     |
| Sulphate of soda, neutral - }                                                    | $NaO, SO_3$                                                 | 71.0                                                     |
| Sulphite of potassa, neu-<br>tral - - - }                                        | $KO, SO_2 + 2HO$                                            | 97.2                                                     |
| Sulphuretted hydrogen<br>(hydrosulphuric acid) }                                 | $HS$                                                        | 17.0                                                     |
| Sulphuric acid, English - }                                                      | $SO_3 + HO$                                                 | 49.0                                                     |
| Sulphurous acid - - - }                                                          | $SO_2$                                                      | 32.0                                                     |
| Tannic acid (Tannin) - - }                                                       | $C_{18} H_8 O_9 + 3HO$                                      | 212.0                                                    |
| Tartrate of ammonia, acid - }                                                    | $NH_4 O, 2\overline{T} + HO$                                | 167.0                                                    |
| “ “ “ neu-<br>tral - - - }                                                       | $OH_4 O, \overline{T} + HO$                                 | 101.0                                                    |
| Tartrate of sesquioxide of<br>iron - - - }                                       |                                                             |                                                          |
| Tartrate of bitartrate (or<br>acid tartrate) of sesqui-<br>oxide of iron - - - } |                                                             |                                                          |
| Tartrate of sesquioxide of<br>iron and ammonia - }                               |                                                             |                                                          |
| Tartrate of sesquioxide of<br>iron and potassa - }                               |                                                             |                                                          |
| Tartrate of sesquioxide of<br>iron and soda - - - }                              |                                                             |                                                          |
| Tartrate of potassa, acid or<br>bitartrate - - - }                               | $KO, 2\overline{T} + HO$                                    | 188.2                                                    |

| NAME.                                  | FORMULA.                                                        | EQUIVALENT, OR<br>MIXING<br>PROPORTION.<br>HYDROGEN = 1. |
|----------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------|
| Tartrate of potassa, neutral -         | $\text{KO}, \bar{\text{T}}$                                     | 113.2                                                    |
| “ “ soda, neutral -                    | $\text{NaO}, \bar{\text{T}} + 2\text{HO}$                       | 115.0                                                    |
| Tartaric acid - - {                    | $\text{C}_4 \text{H}_2 \text{O}_5 + \text{HO} = \bar{\text{T}}$ | 75.0                                                     |
|                                        | + HO }                                                          |                                                          |
| Tin, binoxide of (Stannic acid - - - { | $\text{SnO}_2$                                                  | 74.8                                                     |
| Turpentine, oil of - -                 | $\text{C}_5 \text{H}_4$                                         | 84.0                                                     |
| Uvic acid - - - {                      | $\text{C}_4 \text{H}_2 \text{O}_5 + \text{HO} +$                | 84.0                                                     |
|                                        | aq. = $\bar{\text{U}}$ }                                        |                                                          |
| Water - - - - -                        | HO                                                              | 9.0                                                      |

## RETAIL PRICE LIST.


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Our Photographic Chemicals are neatly put up in flint-glass bottles, with labels uniform and engraved. For those marked with an (\*) an extra charge is made for bottles.

The prices marked are the present New York prices. We shall sell as low always as any respectable dealer; but we wish it distinctly understood that we do not purpose to sell cheaper, except when quality is considered.

The prices on some of our articles are variable. Our customers will receive the benefit of changes as soon as made.

A discount will be made on large orders. If purchasers wish it, we can send the bill for goods ordered by the express agent, to be paid on delivery of them.

 TERMS, CASH.

|                               |               |
|-------------------------------|---------------|
| Acid Acetic, No. 8*           | \$ 30 per lb. |
| “ “ Glacial                   | 3 00 “ lb.    |
| “ Gallic                      | 60 “ oz.      |
| “ Pyrogallie                  | 4 00 “ oz.    |
| “ Formic                      | 1 50 “ oz.    |
| “ Muriatic (pure)*            | 50 “ lb.      |
| “ “ (commercial)*             | 12 “ lb.      |
| “ Nitric (pure)*              | 50 “ lb.      |
| “ “ (commercial)*             | 18 “ lb.      |
| “ Sulphuric (pure)*           | 50 “ lb.      |
| “ “ (commercial)*             | 06 “ lb.      |
| “ Hydrofluoric                | 1 50 “ oz.    |
| Alcohol (commercial) variable | —             |
| “ (nearly absolute) variable  | —             |
| “ “ “                         | 75 “ lb.      |
| Ammonia (pure)                | 50 “ lb.      |
| “ Muriate                     | 06 “ oz.      |
| Ammonium, Iodide              | 2 00 “ oz.    |
| “ Bromide                     | 2 00 “ oz.    |
| Bromine, American             | 75 “ oz.      |
| “ German                      | 1 00 “ oz.    |
| “ Chloride                    | 1 50 “ oz.    |
| Calcium, Chloride             | 12 “ oz.      |

|                             |                    |
|-----------------------------|--------------------|
| Cadmium, Bromide .....      | \$3 00 per oz.     |
| “ Iodide .....              | 3 00 “ oz.         |
| “ Chloride .....            | 1 50 “ oz.         |
| Chloroform .....            | 1 25 “ lb.         |
| Collodion* .....            | 2 00 “ lb.         |
| “ Iodized* .....            | 3 00 “ lb.         |
| Distilled Water* .....      | 12 “ gal.          |
| Ether, Sulph. (pure)* ..... | 50 “ lb.           |
| Gelatine (French) .....     | 50 “ lb.           |
| “ (sheet) .....             | 50                 |
| Gold, Chloride .....        | 15 grs. 75         |
| “ “ and sodium .....        | “ 75               |
| “ “ “ small bottles, .....  | 4 00 per doz.      |
| “ Salt .....                | 15 grs. 75         |
| “ Oxide .....               | “ 1 25             |
| Gun-Cotton .....            | 1 00 per oz.       |
| Gutta-Percha .....          | 1 00 “ lb.         |
| India Ink .....             | 25 “ stick.        |
| Iodine .....                | 60 “ oz.           |
| “ Resublimed .....          | 80 “ oz.           |
| “ Bromide .....             | 2 00 “ oz.         |
| “ Chloride .....            | 2 00 “ oz.         |
| Iron, Protosulphate* .....  | 12 “ lb.           |
| “ Persulphate .....         | 1 00 “ lb.         |
| Ivory-Black .....           | 25 “ flask.        |
| Lime, Bromide .....         | (ounce Brom.) 1 00 |
| “ Iodide .....              | “ 1 00             |
| “ Chloride (pure) .....     | 25 per oz.         |
| Mercury (pure) .....        | 1 50 “ lb.         |
| “ Bichloride .....          | 12 “ oz.           |
| Nitre, Refined (pure) ..... | 25 “ lb.           |
| “ “ Dupont's .....          | 25 “ lb.           |
| Potash .....                | 12 “ oz.           |
| Potassium, Bromide .....    | 75 “ oz.           |
| “ Chloride .....            | 12 “ oz.           |
| “ Cyanide .....             | 1 25 “ lb.         |
| “ Fluoride .....            | 1 25 “ oz.         |
| “ Iodide (variable) .....   | 50 “ oz.           |
| Rotten-stone, Refined ..... | 50 “ lb.           |
| “ Calcined .....            | 63 “ lb.           |
| Rouge .....                 | 38 “ oz.           |
| Silver, Chloride .....      | 1 75 “ oz.         |
| “ Cyanide .....             | 1 75 “ oz.         |
| “ Iodide .....              | 2 00 “ oz.         |
| “ Nitrate .....             | 1 25 “ oz.         |
| “ Oxide .....               | 2 00 “ oz.         |

|                                                                                                    |               |
|----------------------------------------------------------------------------------------------------|---------------|
| Sodium, Chloride (pure).....                                                                       | \$ 25 per lb. |
| Sugar of Milk.....                                                                                 | 75 " lb.      |
| Tannin.....                                                                                        | 25 " oz.      |
| Soda, Hyposulphite (in bulk).....                                                                  | 25 " lb.      |
| " " (lb. bottles).....                                                                             | 30 " lb.      |
| Zinc, Chloride.....                                                                                | 50 " oz.      |
| " Iodide.....                                                                                      | 1 25 " oz.    |
| " Bromide.....                                                                                     | 1 25 " oz.    |
| Varnish, Negative.....                                                                             | 1 50 " lb.    |
| " Positive.....                                                                                    | 1 50 " lb.    |
| " Amber.....                                                                                       | 3 00 " lb.    |
| " Crystal.....                                                                                     | 3 00 " lb.    |
| Printing Machines, French and our own manufacture, \$1 50.                                         |               |
| The best French Positive and Negative Photographic Paper, 8 cts. per sheet,<br>or \$6 per hundred. |               |
| Embossed Mounting-boards, 10 cts. to \$1.                                                          |               |

We shall keep constantly on hand the best qualities of Photographic Paper, of French, English, German, and our own manufacture; Plain and Embossed Mounting-boards, &c.

Funnels and vessels of Gutta-percha, Porcelain, and Glass. Polishing Cotton, Cleaning Paper, Colors for Photographic Pictures, Books on Photography, Stereoscopes, &c., &c.

Letters of inquiry about prices, use of chemicals, processes, &c., will be cheerfully and promptly answered.

HEATH & BROTHER,

Manufacturing Chemists,

324 BROADWAY, NEW YORK.

## TESTIMONIALS.

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NEW YORK, October 26, 1854.

After a careful test by use of the Chemicals of HEATH & BROTHER, I would cheerfully recommend them to the favor of Daguerreian operators. Their Chloride of Gold, Mercury, Acids for Photography, &c., I consider equal to any I have ever used.

M. M. LAWRENCE,  
*No. 381 Broadway, N. Y.*

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BOSTON, October 24, 1854.

MESSES. HEATH & BROTHER:—Your samples of Chemicals came duly to hand. I am much pleased with them. I think, from their action, that they are what they purport to be, chemically pure. Please send me, &c.

J. A. WHIPPLE.

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NEW YORK, November 7, 1854.

I have carefully tested the "Salts of Gold," Rouge, and some of the other articles of their manufacture, and cheerfully recommend them as equal or superior to others.

S. ROOT,  
*No. 363 Broadway, N. Y.*

---

After a careful trial of the Daguerreotype Chemicals of Messrs. HEATH & BROTHER, I take pleasure in expressing my favorable opinion. The Chemicals I consider superior to any I have ever used.

O. T. PETERS,  
*Stereoscope Gallery, 394 Broadway, N. Y.*

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NEW YORK, November 8, 1854.

We take pleasure in commending the Chemicals of Messrs. HEATH & BROTHER to the favorable notice of Daguerreotype artists.

GURNEY & FREDERICKS,  
*No. 349 Broadway, N. Y.*

---

NEW YORK, November 4, 1854.

We have carefully tested some of the Chemicals of Messrs. HEATH & BROTHER, and can say they are equal to any we have ever used.

MEADE BROTHERS,  
*No. 233 Broadway, N. Y.*

EASTON, PA., October 12, 1854.

Your Chemicals are excellent. In future I shall purchase of you, and advise my friends to do the same.

G. W. HOPE.

ITHACA, September 28, 1854.

Your Crystallized Chloride of Gold excels all I have ever used. \* \*  
I shall use no other, if yours can be procured.

G. BARTHOLOMEW

NEW YORK, October 19, 1854.

For purity and reliability, I consider the Photographic Chemicals of Messrs. HEATH & BROTHER equal to any others now in market.

M. B. BRADY,

Nos. 205 and 359 Broadway, N. Y.

DETROIT, Michigan, May, 1855.

GENTLEMEN:—Your Chemicals work beautifully: I am now taking Photographs in the best style. I shall no doubt do a large business with you.

Yours truly,

MESSRS. HEATH & BROTHER.

G. E. HALL.

COLUMBUS, Ohio, April, 1855.

DEAR SIRS:—I am taking better Photographs with your Iodized Collodion than any I have before seen. Send me this order by the first express, as the *rush* has nearly consumed the last lot.

Respectfully yours,

MESSRS. HEATH & BROTHER, N. Y.

H. LYNDALL.









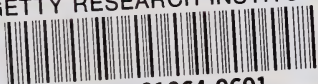




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